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THE SCHEMA OF INTROSPECTION

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1. *Introspection as a Generic Term*

I have shown in a previous paper[1] that the term Introspection, as we find it used to-day, is highly equivocal, and that the procedure which it connotes may be scientifically illegitimate, or even wholly imaginary. I reserve the name henceforth for methods that are scientifically available and that appear to have been actually employed. The plural form 'methods' is still in order; for introspection, even with this limitation, remains a generic term and, in so far, a term of equivocal meaning. Let us suppose that the 'subjective' conditions of observation—observational type, general training and special practice, temporary disposition and the like—have all been standardised: nevertheless, the course that an observer follows will vary in detail with the nature of the consciousness observed, with the purpose of the experiment, with the instruction given by the experimenter. Introspection is thus a generic term, and covers an indefinitely large group of specific methodical procedures.

The common trait that holds these methods together may be characterised in various ways. We may say, for example, that all introspection presupposes the standpoint of descriptive psychology. The results to which it leads belong to what Jevons calls 'empirical knowledge,'[2] and are logically

[1] Prolegomena to a Study of Introspection, this Journal, xxiii, 1912, 427 ff.

[2] W. S. Jevons, *The Principles of Science*, 1900, 526 ff.

prior to any sort of systematisation of conscious phenomena. There are, to be sure, different levels of psychological observation: we may accept a terminology, or a generalisation, or the preliminary chapters of a system, and may proceed to observe in these terms and on this basis; and there are, again, different backgrounds of observation: we may postulate a certain type of system, and so commit ourselves beforehand to a particular mode of explanation. But the data of introspection are never themselves explanatory; they tell us nothing of mental causation, or of physiological dependence, or of genetic derivation. The ideal introspective report is an accurate description, made in the interests of psychology, of some conscious process. Causation, dependence, development are then matters of inference.[3]

We may say, again, that the introspective methods do us the same service in psychology that the inspective methods—'observation and experiment' is the more usual phrase—do in natural science. To get a rough appreciation of the scope and the limitations of introspection, we have then only to shift the scene to chemistry or biology, and to realise what can be accomplished in those sciences by methods of direct and indi-

[3] I quote a few passages. In general, "introspection of itself cannot furnish a theory of our psychical processes:" O. Külpe, *Grundriss der Psychologie*, 1893, 10. As regards causation, "association, the connection of ideas, is not a phenomenon of consciousness. . . . We thus formulate an hypothesis; we do not note a fact of consciousness that is evident of itself:" E. Claparède, *L'association des idées*, 1903, 6 f. As regards dependence, "the sensation as such . . . neither refers us to the organs in which it has arisen under the operation of external or internal stimuli, nor indicates the character of these stimuli themselves:" W. Wundt, *Phys. Psychol.*, i, 1893, 412; cf. *Philos. Studien*, ii, 1885, 302 ff. As regards development, "psychology, in order to make valid its claim to be a science, must not merely display" the facts ascertained by introspection; it must also, among other things, "trace the stages of their development from what is simpler to what is more complex:" G. T. Ladd, *Elements of Physiol. Psych.*, 1887, 10; cf. J. M. Baldwin, *Mental Development in the Child and the Race: Methods and Processes*, 1895, 3 (where the 'genetic conception' is placed under the heading 'explanation' as opposed to 'description'). Indeed, the statement of the text would be simply a commonplace were it not that this natural limitation of the observational method is sometimes made a reproach to introspection. Cf., *e. g.*, R. Dodge, The Theory and Limitations of Introspection, this JOURNAL, xxiii, 226: "Introspection has never been able to fill out the causal relations of any fact of consciousness," etc. But neither does external observation reveal physical causation; that is always an inference,—based on observation, and confirmed by observation, but none the less an inference. Or cf. N. Kostyleff, Les travaux de l'école de Wurzbourg: contribution a l'étude objective de la pensée, *Rev. philos.*, lxx, 1910, 554, 570, 576, 580.

rect observation. There is, perhaps, no reason to fear that this statement will be misinterpreted; but to avoid possible misunderstanding I add two qualifying remarks. In the first place, if we are to interpret it aright, we must free ourselves of the popular belief that the experiment of natural science is an explanatory test; we must recognise that, while an experiment may have an explanatory value, it is itself observational. And in the second place we must remember that the resemblance between inspection and introspection is a broad and general likeness, which consists with all manner of difference in degree and in detail. It has, of course, been customary for psychological text-books to emphasise these differences; and I do not suppose that the weight of tradition and authority can be overcome all in a moment. I am convinced, however, that the right way to approach the study of psychological method is to assume that it is, in all essentials, identical with the observational procedure of the natural sciences.[4]

The thesis that introspection is simply the common scientific method of observation, applied from the standpoint of a descriptive psychology, was maintained explicitly by Pillsbury in 1904: "It would seem that introspection differs from [external] observation only in the attitude of mind as we examine the mental process."[5] I argued to the same

[4] With the above paragraphs cf. G. E. Müller, *Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufes*, i, 1911, 63 *sub fin.*, 81 ff. Readers of my earlier paper will not need to be reminded that I mean here, by 'psychological experiment,' such an experiment as only a man with specifically psychological training is capable of performing. Many other sorts of experiments are made, by psychologists, in the interest of the psychological system; and these may properly be termed, in another context, 'psychological experiments;' but they are not now under discussion.

[5] W. B. Pillsbury, A Suggestion toward a Reinterpretation of Introspection, *Jour. Phil. Psych. Sci. Meth.*, i, 1904, 228. The title of this paper shows that the author regards his position as novel. He thinks, however, that it is implied in the work of Wundt and Külpe; and, indeed, if we accept formal statement in the one case and actual procedure in the other, we may find evidence to that effect: see, *e. g.*, W. Wundt, *Logik*, ii, 2, 1895, 170 ff.; O. Külpe, *Grundriss der Psych.*, 1893, 8 ff. The same thing may be said of H. Münsterberg, *Ueber Aufgaben und Methoden der Psych.*, 1891, 145, 153 ff. It is notoriously difficult, in cases like this, to refer an idea specifically to men and dates. James, *e. g.*, declares that psychology is a natural science, and yet offers an account of introspection that differentiates it from external observation (W. James, *Princ. of Psych.*, i, 1890, 183 ff.). Robertson writes that "psychology, by itself, is in the first instance positive phenomenal science—positive as to its method, phenomenal as to its subject-matter. Its method does not differ from that of other positive sciences, like biology or chemistry, except as the method of any science is modified by the peculiarity of its subject." There is, however, an

effect in 1908;[6] and Müller has taken a like position in his recent work on Memory.[7]

But if this thesis is correct, have we any reason for keeping the term introspection in our psychological vocabulary? None at all, I think, if we consider the matter from the point of view of an abstract methodology. On the other hand, this introspection, or observation from the standpoint of psychology, is the unique business of the psychologist; it is something that the psychologist's training fits him to do, and that no other form of scientific training leads up to or includes. Everything else that belongs to the system of psychology can, formally or theoretically, be done just as well by the physicist or biologist as by the psychologist,—though it is true that adequate and satisfactory explanations in psychology may be expected rather from the man with special psychological training and knowledge than from the student of general science or from the specialist in some other field. Introspection, then, is in a peculiar and exclusive sense the business of the psychologist, and it is well that this business should have a specific name. When, moreover, we have a traditional term, that is full of misleading suggestions to the student, it is wiser to adopt that term, reading the suggestions out and reading a sound definition in, than to pass it by and introduce a new coinage.

The Stimulus Error.—It would be foolish to blink the fact that our current text-books still point out a number of alleged differences between introspection and inspection. In the main, however, these statements do not rest upon empirical induction, but rather derive from the authors' epistemology. The truly empirical differences will be variously rated by different psychologists; the time is not yet ripe for a point-by-point comparison of the methods. Meanwhile, those psychologists who do not regard the differences as fundamental must walk warily, or they will find that, so far as the teaching of psychology is concerned, they have bought their insight at a high price. The idea of an unique method, a specific way of working, is far more easily grasped by the beginner in psychology than is the idea of a shift of mental attitude. Indeed, the reformed doctrine opens a wide door to the 'stimulus error.' The observer in a psychological experiment falls into this error, as we all know, when he exchanges the attitude of descriptive psychology for that of common sense or of natural science; in the typical case, when he attends not to 'sensation' but to 'stimulus.' Now, in work upon color-equations, *e. g.*, it makes little difference whether the observer regard himself as matching color-sensations or colored papers. But one cannot make any large number of observations, even in the simplest fields of sense, without discovering that the confusion of attitudes has very serious consequences. The stimulus error is, in fact, the material aspect of what appears, in more formal guise, as the error of logical reflection or of *Kundgabe;* it is an error both subtle and pervasive; and the more closely our psychological

'in the second instance' which marks off psychology, method and problem alike, from the natural sciences (G. C. Robertson, Psychology and Philosophy, *Mind,* O. S. viii, 1883, 9; *Elements of Psychology,* 1896, Editor's introduction, xi). J. S. Mill declares that there is a science of mind, whose methods are observation and experiment (*A System of Logic,* bk. vi, ch. 4, § 2 [1884, 556]); but I need not say that we should go far astray if we took this statement *au pied de la lettre.*

[6] *Feeling and Attention,* 1908, 175 ff., 354 ff. Cf. *Text-book,* 1909, 19 ff.; R. M. Yerkes, *Introduction to Psychology,* 1911, 39 ff.

[7] *Op. cit.,* 64 ff., 81 ff.

method approximates the methods of observation employed in other laboratories or in daily life, the greater is the likelihood that our students fall victims to it.

The stimulus error may even affect our views of introspection itself. At a recent meeting of Experimental Psychologists it was urged, with special reference to tachistoscopic experiments, that introspection is wholly unreliable; for if we compare the observer's reports with the stimuli actually exposed, we find that he may see what was not there at all, may fail to see much of what was there, and may misrepresent the little that he really perceived; introspection adds, subtracts, and distorts. The question, however, so far as the validity of introspection is concerned, is not whether the reports tally with the stimuli, but whether they give accurate descriptions of the observer's experimental consciousness; they might be fantastically wrong in the first regard, and yet absolutely accurate in regard to conscious contents. In other words, the objection issues from the stimulus error. The observer is trying to describe a consciousness; not certain objective letters or figures, but the consciousness which a brief exposure of these stimuli induces. His description may be mistaken or inadequate, and we must use every possible methodological means to discover its mistakes and to supplement its omissions; but we cannot gauge the method by reference to the stimuli.

It seems, therefore, that if we assimilate introspection to inspection we must, in laboratory practice, be more than ever on our guard against the stimulus error. We shall invert Steinthal's story;[8] and, letting geologist, farmer, landscape gardener, psychologist, traverse and report upon the same bit of country, we shall explain that all four reports may be equally true, but that each one plainly implies a particular attitude, a special point of view. It is the attitude and point of view, not the method, which must henceforth serve to distinguish the introspecting from the inspecting man of science.

Phenomenology and Descriptive Psychology.—I have tried in other writings to show the nature of this 'descriptive psychology' whose methods are summed up by the term 'introspection.' On the positive side, I have here nothing new to add. On the negative side, I would warn the reader against confusing descriptive psychology with a 'phenomenological' account of mind. The word 'phenomenology' has played a large part in recent discussion, and has been variously defined. In the present connection I mean, by a phenomenological account of mind, an account which purports to take mental phenomena at their face value, which records them as they are 'given' in everyday experience; the account furnished by a naïve, common-sense, non-scientific observer, who has not yet adopted the special attitude of the psychologist, but who from his neutral standpoint aims to be as full and as accurate as the psychologist himself. It is more than doubtful whether, in strictness, such an account can be obtained. We can hardly, with the pressure of tradition and of linguistic forms upon us, consider mental phenomena in a really naïve way, with a truly blank prescientific impartiality; our common sense runs to logic, embodies a psychology of reflection; face values are, in fact, highly sophisticated values, and things given are things that have been many times made over. The proof, if proof be needed, is that phenomenology, when it leaves what might be thought its proper sphere of gross description and

[8] H. Steinthal, *Einleitung in die Psychologie und Sprachwissenschaft*, 1881, 167 f.; translated by W. James, *Principles of Psychology*, ii, 1890, 108.

takes to analysis, tends inevitably to analyse under logical categories; it works out implications, while descriptive psychology—under the same *Aufgabe* of analysis—teases out the existential factors in the consciousness to be described. A phenomenological 'system' is therefore an epistemological *tour de force*, rather than a prepsychological synthesis of the data of psychology.

We need not hesitate to admit, on the other hand, that a roughly phenomenological account, a description of consciousness as it shows itself to common sense, may be useful or even necessary as the starting-point of a truly psychological description. The psychologist may attempt it; or it may be supplied by the novelist, or the diarist, or by any untrained but alert observer. The psychologist may also have recourse to phenomenology after the event, after he has completed his own first analysis, as an additional check upon the singly motived and more technical description. Or again, the elaborate phenomenology that issues from a foregone epistemology may be of service as indicating possible *lacunae* in psychological description. But phenomenology, as I am here using the term, is not psychology; and if, as will naturally be the case, phenomenological and psychological results are sometimes in accord, this casual agreement must not tempt us to generalisation or lead us to identify different attitudes toward experience.[9]

2. *The Introspective Schema: Free and Controlled Consciousness*

In an attempt to reduce observation to its lowest scientific terms, I have said that it "implies two things: attention to

[9] The phenomenology that I have in mind is, of course, that of Husserl, and not that of Brentano and Stumpf. An adequate discussion would require another article; I can here only express my opinion that no form of phenomenology—phenomenology of mind, *Gegenstandstheorie*, science of selves—can be truly scientific, for the reason that the implied attitude to experience is multiply motived and fluctuating, while the *minimum* requirement of science is a fixed and constant point of view.

With the general subject of the above paragraphs, cf. A. Messer, Husserls Phänomenologie in ihrem Verhältnis zur Psychologie, *Arch. f. d. ges. Psych.*, xxii, 1911, 117 ff.; W. Wundt, Psychologismus und Logizismus, *Kleine Schriften*, i, 1910, 511 ff.; and, more especially, G. Reichwein, *Die neueren Untersuchungen über Psychologie des Denkens nach Aufgabestellung, Methode und Resultaten übersichtlich dargestellt und kritisch beurteilt*, 1910, 116, 125 f., 136. This work, a doctorate thesis of the University of Halle, written under Meumann's direction, seems to have failed of its due recognition, both in Germany and in America. It undertakes a detailed comparison of Wundt's psychology of thought with the doctrines of the Würzburg school; and the author maintains, I think correctly, that Wundt's position, whether right or wrong upon special points, is more consistently psychological and implies a wider psychological perspective than that of his opponents. The comparison is all the more timely since the Würzburg authors have, in general, made little more than incidental reference to Wundt, and since Wundt's views have been grossly misrepresented by certain critics (J. B. Sauze, L'école de Wurtzbourg et la méthode d'introspection expérimentale, *Rev. de philos.*, xviii, 1911, 225 ff.; F. A. Gemelli, L'introspezione sperimentale nello studio del pensiero e della volontà, *Riv. di psicol. appl.*, vii, 1911, 289 ff.).

the phenomena, and record of the phenomena."[10] Psychological observation implies, accordingly, an attention from the standpoint of psychology, and a record in the terms and under the captions of psychology. And if we are seeking a first, provisional classification of the introspective methods, we shall look for salient differences in the conditions under which attention is given and record is made.

This course is, in fact, followed by Müller in his recent work on Memory. The essential thing in every case of introspection, Müller says, is that some conscious process or part-process, some state of consciousness or complex of states of consciousness, is made the object of a 'conscious psychological apperception.' This apperception is an appraisement, a judgment, a 'placing,' from the psychological standpoint, of the state or process which is to be observed. It may be explicit, consisting of a "properly formulated sentence in internal speech, to which may even be added an inner comment such as 'important!' or 'don't forget!'" Or again it may be sketchy and fleeting, and make but little claim upon consciousness,—consisting perhaps of the bare suggestion (*das mässig deutliche Anklingen*) of verbal glosses, visual ideas, and so forth. The method is completed by a description, which gives the apperception or appraisement "a linguistic expression in accordance with instruction."

If now we take the psychological apperception as the basis of a classification, we have two principal forms of the introspective method. In Direct Introspection, the process under observation is apperceived immediately, while it is still present. There are then two possibilities: description may be made at once, or may be deferred to a later time and based upon a remembered apperception. In Indirect Introspection, on the other hand, the process to be observed is recalled, as a memory image, and apperception and description have reference to this representative memory-process. If we tabulate, we get the three following procedures:

I. Direct Introspection.
   1. Process and apperception occur together. Description is made on the basis of present immediacy.
   2. Process and apperception occur together. Description is made on the basis of remembered apperception.

II. Indirect Introspection. Process is recalled as memory-image. Apperception is of memory-image, and description is made on the basis of this apperception.

[10] *Text-book*, 1910, 19 f.

This appears to be, essentially, a classification in terms of what I have called 'attention.' In practice, however, indirect introspection and the second form of direct introspection are likely to run together; and it is therefore more useful to classify on the ground of 'record' or description. The description of a conscious process—I am still paraphrasing Müller—may be immediate, or may be mediated by retrospection. In the former case, the subject-matter of description is the observed process itself. The process may perhaps change while the description is still in course, just as a firework may change to blue while we are still exclaiming 'What a glorious red!'; but the description attaches, none the less, to the actual process. In the second case, description is made from a representative memory of the process; or from memory of a psychological apperception of the process; or from a combination of these two memories.[11] If we tabulate, we have:

[11] G. E. Müller, *op. cit.*, 68 ff., 81 ff. Esp. 69 (cases in which a psychical process or part-process is *beurteilt oder kommentiert* from the psychological standpoint are cases of conscious psychological apperception); 70 f. (various levels of psychological apperception); 86 f. (in all cases of introspection, a conscious state or a complex of states is judged [*ein Urteil gefällt wird*] from the psychological standpoint); 87 notes (negligible cases); 88 (*die Beurteilung, welcher die Beschreibung einen vorschriftsmässigen sprachlichen Ausdruck gibt*).

So far as I can judge, my own terms 'attention' and 'record' cover the procedure that Müller characterises as psychological apperception and description, with the difference that Müller is speaking in the concrete, while my treatment is abstractively analytical. If we have recourse to formulas, Müller's method is (*psychological apperception*) ⟶ *description*, and mine is *psychological* (*attention, record*). Müller, in other words, emphasises the empirical unitariness of the particular introspection, and thus includes under apperception things that I should refer to psychological *Aufgabe* and to record. Müller's statement is, however, so brief that I cannot be perfectly sure of this interpretation.

I am inclined to think that, wherever in this discussion Müller uses the term memory (*Erinnerung an*), he has in mind a reproduction in kind, a representative memory. This is certainly intended when the memory of the conscious state or process itself is spoken of; cf. the phrases *in der Erinnerung wieder vergegenwärtigen* and *Erinnerungsbild* on p. 65 (description of an external object). I think that it is also intended when an apperception is said to be remembered: cf. the *vergegenwärtigt* of p. 68, and the instances given, pp. 65 f. In the latter case, however, I imagine that a symbolic memory would serve the purpose.

Münsterberg (*op. cit.*, 170) rules out 'pseudo-memory by verbal description' altogether. His point of view in this passage is, however, different from that of Müller, and I see no reason why he should

I. Immediate Description, on the basis of immediacy of process and present apperception.
II. Retrospective Description:
  1. On the basis of present apperception of a memory-image of the process;
  2. On the basis of a remembered apperception, which itself occurred when the process was given;
  3. On the mixed basis of these two memories.

At this point Müller introduces an important distinction,—the distinction of free and controlled consciousness. A conscious state or process is free when it is neither evoked nor influenced by the intent to observe; it is controlled when it arises under the influence of an introspective intent and as the object of a consequent attention especially directed upon it. We have, plainly, no right to generalise a priori from the controlled to the free; whenever generalisation is made, it must be justified by a statement of its methodological grounds. Nor is the line of division, in every case, easy to draw; we may slip insensibly, as we make our instructions more and more precise, from freedom to control. On all accounts, then, and whatever be the phase of introspection that we are examining, the distinction of free and controlled consciousness must be borne explicitly in mind.[12]

The distinction thus drawn must not be confused with that contained in the old-time objection to experimental psychology, that observation in the laboratory is observation under artificial conditions, and can therefore tell us nothing of the real mind.[13] For the disjunction real-artificial is not identical with free-controlled; and free consciousnesses may be studied in the laboratory not only as well as, but even better than they can be studied in everyday life.[14] Nor must the distinction be confused, again, with that of 'spontaneous' and 'voluntarily aroused,' which the studies of mental imagery have made familiar; for an image, though it rise spontaneously, may be made by

not accept Müller's 'remembrance of an apperception' as a factor in psychological method. On the other hand, Münsterberg believes that introspection is impossible without a previous knowledge of anatomy and physiology (*op. cit.*, 160, 164). Here I cannot follow him.

[12] *Op. cit.*, 73, 79, 95, 98 f., 120. The passage 98 f. describes a case in which generalisation is, within certain limits, permissible.

[13] See, *e. g.*, J. M. Baldwin, *Handbook of Psychology: Senses and Intellect*, 1890, 30; H. Münsterberg, *op. cit.*, 234; O. Külpe, *op. cit.*, 12; W. Wundt, *Logik*, ii, 2, 1895, 175; J. McK. Cattell, *Psych. Rev.*, iii, 1896, 141. The distinction drawn by Müller is, again, not the same as Münsterberg's classification by natural and artificial (*i. e.*, experimental) conditions: *op. cit.*, 149 f., etc.

[14] It is therefore unfortunate that Müller uses the terms 'natural' and 'constrained.' The antithesis of natural is unnatural or artificial; and, as Müller expressly says (*op. cit.*, 73 *note*), the constrained processes are by no means unnatural.

instruction the object of a particular attention, and in so far is a controlled process.[15]

The distinction must be observed by all those psychologists who use the phrase 'mental process' or 'mental phenomenon' as identical with, or inclusive of, what the older psychologies term 'conscious contents.' Introspection of a free consciousness may demand, for instance, the description of processes at various levels of attention.[16] The distinction seems to lapse, on the other hand, for all those who, with Stumpf, regard conscious contents or 'phenomena' as in principle independent of the function of 'perceiving' or 'remarking' or 'taking notice.' All that remains of it, if I read Stumpf correctly, is a difference of degree in the function itself,—a difference, as he figuratively expresses it, in the amount of consciousness directed toward (*die Ansammlung von Bewusstsein gegenüber*) a particular phenomenon. I cannot, of course, enter here upon a criticism of this other distinction, of act and content, function and phenomenon.[17] It is, however, worth noting, as a sign of the immaturity of psychology and of its imperfect separation from philosophy, that the empirical difference of free and controlled consciousness is dismissed, in certain modern systems, by a wave of the epistemological wand.

3. *Consciousness as the Object of Introspective Description*

Let us assume, for the purposes of the present argument, that Müller's schema of introspection is both adequate to and applicable by a descriptive psychology. Müller is writing primarily, of course, with reference to the special psychology of Memory; and he finds it necessary, even in this restricted field, to supplement the bare statement of method by a long list of cautions and regulative maxims. The main points of his exposition may lay claim, nevertheless, to general psychological validity.[18] I assume, therefore, that in introspection we are describing a conscious process at first hand, or describing at first hand the representative memory of a past process, or describing from memory the way in which we 'placed' some past process at the time of its occurrence. And I assume, further, that we have the skill to make

[15] The distinction runs through the 'literature' of imagery, from G. Cardano in the sixteenth century to G. H. Betts in the twentieth. On the control of a spontaneous image cf. Müller, *op. cit.*, 78 f.

[16] I have shown elsewhere how my own formula deals with this case. See Attention as Sensory Clearness, *Jour. Philos. Psych. Sci. Meth.*, vii, 1910, 180 ff.

[17] I have discussed certain aspects of the distinction in *Thought-processes*, 1909, 41 ff. The act-psychology seems to me to reach its *reductio ad absurdum* in S. Alexander's Foundations and Sketch-plan of a Conational Psychology (*Brit. Jour. Psych.*, iv, 1911, 239 ff.), which swings us from the *vis repræsentativa* of faculty days to the opposite pole of conation.

[18] Müller himself writes (*op. cit.*, 63) that his "general account of the nature and forms of introspection, and the principal formulae and rules given in the course of the discussion, are to be regarded as generally valid."

this description in psychological terms and to keep it within psychological limits. Now the question arises: What are the categories of description? or, in other words: What is consciousness as describable object?

The categories of description, I should reply, are the last terms of analysis, the elementary processes and their attributes; and consciousness has been described when analysis is, qualitatively and quantitatively, complete. This reply I take to be formally correct. / In practice, it needs a twofold qualification: for, first, psychologists are not yet at one as regards the nature and number of elementary processes and their attributes; and, secondly, psychology is not yet able to cope, in thorough-going analytical fashion, even with a moderately complex formation, to say nothing of a total consciousness.) Both points are illustrated by the recent work upon Thought. In this field, experimental evidence is offered for a new elementary process, a thought-element, with its own attributes and its own laws of connection; while at the same time there is fairly general agreement that the observational methods at present available are not adequate to a full description of the thought-consciousness. The qualifications do not, however, affect the formal accuracy of the original statement.

We are here upon highly debatable ground. I therefore add, even at the risk of threshing old straw, brief comments upon the terms employed in the above paragraph; and I discuss certain corollaries that follow from my attitude to the question which it seeks to answer.

The Need of Analysis.—It would be unnecessary to insist upon the primary necessity of analysis, were it not that protest is often raised against the analytical treatment of consciousness and the resulting 'atomistic' psychology. Ebbinghaus has met this protest in a form which deserves to become classical.[19] I shall not repeat his argument, but I will supplement it by reference to two concrete cases. The psychologists who have stood most emphatically for the continuity of consciousness are, I suppose, Ward and James. "Mind," says Robertson, "has the character—a character adequately brought out only by Dr. Ward among psychologists—of continuity as its most prominent, salient feature."[20] Yet the first chapter-heading of Ward's *Psychology* is 'General Analysis.'[21] James' chapter on The Stream of Thought, which has already become a classic upon the anti-atomistic side, posits the fact that "thinking of some sort goes on." Its author then proceeds: "How does it go on? We notice immediately five important characters in the process." And this discrimination of characters is

[19] H. Ebbinghaus, *Grundzüge der Psychologie*, i, 1897, 164 ff.; H. Ebbinghaus and E. Dürr, *ibid.*, 1911, 177 ff.

[20] G. C. Robertson, *Elements of Psychol.*, 1896, 16; cf. the author's own continuation (17): "science is insight by way of analysis."

[21] J. Ward, *Encycl. Brit.*, xxii, 1911, 548.

obviously an instance of that mode of analysis which James later terms 'the process of abstraction.'[23]

There is no doubt, then, that a descriptive psychology must be analytical. But objection may be taken to the way in which the descriptive psychologist formulates the problem of analysis. Stratton, for instance, rejects the chemical analogy; "we may name the elements to perfection, without a perfect description of the active whole;" "description is more than a statement of elements and their proportions; other relations and modes of interconnection are important."[24] I am not sure that a 'perfect' description can ever be attained.[24] I believe, however, that many of Stratton's *desiderata*—the 'architectural features' of consciousness, the 'manner of behavior' of the constituent processes—would be supplied by an exact description in attributive terms. If the result is still unsatisfactory, it is surely an open question whether description is at fault or whether we are not demanding of description more than it can, by its very nature, give us; whether, that is, our craving for explanation has not led us to cast unmerited reproach on a non-explanatory or pre-explanatory method. Or again, objection may be taken to the results of analysis. Thus Ogden, in reviewing an analytical study of the consciousness of Belief, remarks: "One might imagine that Okabe's results would apply equally well to a description of the aesthetic attitude, the ethical attitude, the consciousness of understanding, or indeed any other of the higher apperceptive states of mind."[25] I do not myself think that description, even in its present immature condition, is so ill bestead. Let us assume, however,—still for the argument's sake,—that an accurate description of 'the higher apperceptive states' fails to discriminate belief from understanding, the moral from the aesthetic judgment. The inference would be, simply enough, that our current differentiation of these consciousnesses is a differentiation of import or value, or in other words that it transcends description. But if this is the fact, it is to our advantage to know it,—while it is foolish to blame the descriptive method for stopping short with description.[26]

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[23] W. James, *op. cit.*, i, 1890, 224 f., 505. The discussion of the Stream of Thought is, in many passages, highly analytical.

[24] G. M. Stratton, Toward the Correction of Some Rival Methods in Psychology, *Psych. Rev.*, xvi, 1909, 75, 80, 84.

[24] Cf. Description *vs.* Statement of Meaning, this JOURNAL, xxiii, 1912, 166.

[25] R. M. Ogden, Imageless Thought: Résumé and Critique, *Psychol. Bulletin*, viii, 1911, 194. A closer study of the data will, I believe, show that Ogden's imagination has misled him. In any case, the descriptive psychology of these 'higher' processes is still only in the pioneer stage.

[26] I suspect that the neglect of Müller's distinction of free and controlled consciousness is responsible for much of the current dislike of psychological analysis. The 'elements' of our text-books are clear-cut affairs, processes isolated from context and set in the high light of attention. It is true that we speak also of laws of connection, and discuss the phenomena of contrast, of fusion, of inhibition, and the like. Yet when we say that a given consciousness is made up, *e. g.*, of kinaesthetic sensations, the reader is apt to think of the kinaesthetic sensations described under that heading in the books, of kinaesthesis focalised and abstracted. But if he tries in this way to synthetise a free consciousness by the juxtaposition of controlled elementary processes, it is no wonder that he comes out with an artificial mosaic which

Process and Function.—Arguments of this sort, however, move only on the surface of things. If we wish to go deeper, we must be clear, first of all, as to what we mean by the term 'process.'

The experimental psychologist, if I understand him, means by process something more than the abstract form of occurrence in time; so that when we say, *e. g.*, that perception is a process, and speak on the other hand of the process of growth, or the process of decay, we are using the word in different meanings. A process, in the psychological sense, is an item of experience to the nature of which durativeness (if the word may be pardoned) is integral and essential. It is true, in the large, that all experience is temporal. Yet there are numberless cases in which the progress of experience is so slow that its process-character may be ignored; we then speak of 'things.' And there are other cases in which the progress is too fast for direct temporal apprehension; we then speak of 'events.' Now it is characteristic of consciousness that its constituents are typically processes. We may find analogies in such experiences as a thunder-storm, a luncheon, an address: here is plenty of content,—heat and rain, thunder and lightning; things to eat and things to drink, speeches and table decorations; topics discussed, introduction and peroration: but it is of the essence of the experience that it occupies a certain, limited time; and its description implies constant reference to this durative attribute. So it is with consciousness. Process is a relative term; and there are times when a conscious complex is relatively so stable that we are justified in applying to it the older term 'state of consciousness' or the more modern 'conscious formation;'[27] just as there are times when the stream of thought is so rapid that we speak of conscious 'events' or 'occurrences.' Nevertheless, Wundt and James are absolutely in the right when they emphasise the 'going on' of thought or of idea; our descriptions of consciousness, if they are to be satisfactory, must be through and through temporal; our vocabulary must be rich in words that indicate the passage and course of time.[28]

Only, once more, the psychological process is not the bare form of temporal occurrence. An experience of perception is, as I have insisted, a durative experience; it is not identical with the percept, the *perceptum*. But neither is it identical with perceiving. This 'act' or 'function' of perceiving is, in my judgment, a logical or epistemological abstraction from the concrete experience; it is not an empirically discriminable feature of perception. And in the same way the static percept, in so far as it is psychological,—in so far, that is, as it stands for conscious content, and not for a thing of common sense or an object

bears small resemblance to the continuum that he is seeking to reproduce. And then arise misunderstandings like that of H. J. Watt, who believes that the 'notion of process' has, in my *Thought-processes*, exercised a 'solvent action upon the precisely definable elements of *The Psychology of Feeling and Attention*' (*Mind*, N. S. xx, 1911, 109, 112).

[27] H. Ebbinghaus, *op. cit.*, i, 1897, 163 f. The passage has disappeared from the edition of 1911. I cannot but regret the systematic changes which Dürr has thought it necessary to introduce into the first volume of the *Grundzüge*. Ebbinghaus had thought things through for himself, and would not, I am sure, have approved of some of these changes. Cf., however, the Editor's preface, xi ff.

[28] I am aware of the summary character of these remarks; and I realise that there is need of a thorough-going historical and critical discussion of our current psychological terms.

of natural science,—is also an abstraction from experience, not empirically discriminable. In other words, it is impossible, by introspective analysis, to break up a perception into perceiving and percept; for that, observation must give place to logic. We may, of course, seize upon some particular moment of perception, which we regard as typical of the whole course, and may be content to describe it and to neglect the past and future, the rise and fall of the total process. For purposes of elementary instruction, more especially, this substituting of the snapshot for the moving picture may be advisable or necessary. But we must still make it clear that what we are describing is a phase of the perception,—not the perception itself, nor yet the percept abstracted from the perception.

In this whole matter of the process, the precept of experimental psychology has been better than its practice. The concept, in Wundt's hands, did yeoman service against the logical statics of associationism. But the analytical work of the laboratories has tended, I think, toward a psychological statics; the temporal aspects of our subject-matter have been unduly neglected. And logic, as if in revenge, has entered psychology by another door, and offers the Stumpfian functions of noticing and classifying, of conceiving and judging, of emotion and appetence, as *Erlebnisse* to be taken account of in any complete description of the 'immediately given.'[29]

The Data of Observation.—As against this view of Stumpf's, I agree with Münsterberg that "what are called inner activities are in fact only contents of consciousness;"[30] though for reasons already given I prefer the term 'content-processes' to the bare 'contents.' We cannot observe an experiencing; we are not called upon, in psychology, to observe an experienced; what we observe is experience.

The 'limitations' of introspection now follow of themselves; they are given with its definition; they are of the same sort as the 'limitations' of a microscope or a camera. We can observe only what is observable; and we cannot observe any product of logical abstraction. We cannot, therefore, observe relation, though we can observe content-processes that are given in relation. We cannot either observe change, though we can observe changing content-processes for so long a time as attention, under the observational *Aufgabe*, may be maintained. We cannot observe causation, though we can observe content-processes that are definitely conditioned. And so it is in other cases. Psychological description can deal only with content-processes under their empirically distinguishable attributes.

In practice, however, description and explanation, or description and inference, are likely to be intermixed and interchanged in the most various ways.[31] It is, indeed, by this continual shift of standpoint that science advances: and I am pleading neither for rigidity of method nor for pedantry of exposition, but only for clear thinking as the work of system-making goes on. When Stratton says that "a host of real relations *apply* to mental data, without necessarily having any conscious presence or representatives among these data,"[32] I heartily agree; a

[29] C. Stumpf, *Erscheinungen und psychische Funktionen*, 1907, 6 f. A succinct account of the 'objects of introspection,' regarded not as content-processes but as contents *and* processes, is given by A. Messer, *Empfindung und Denken*, 1908, 74-78.

[30] *Op. cit.*, 170; cf. *Grundzüge d. Psychol.*, i, 1900, 230.

[31] Cf. p. 486 above.

[32] *Op. cit.*, 82. Cf. my *Text-book*, 1910, refs. to *Predisposition*.

competent experimenter will note the relations. When, however, Stratton continues: "and we must make use of these relations in our psychological description even when we cannot find them there as 'elements' in the fact we would describe," I as positively demur; you cannot describe what you cannot observe; your mention of the external conditions introduces a factor of interpretation, which has nothing to do with psychological description. To add interpretation to description is both human and scientific; to call the result a 'psychological description' is to confuse issues. I find this confusion repeated in the following quotation from Judd. "Once the possibility of recognising a wholly different type of *explanation* is admitted, the conscious process [of perception] will be treated as a complex *made up* of sensory elements and other processes which are functional in character and deserving of a separate treatment. We shall then see that any particular phase of experience may be *described* either with reference to its sensory facts or with reference to its functional phases of activity."[83] But to ascribe 'functional activity' to experience is to interpret it.

The Psychology of Logic.—We are concerned, in this paper, with a right understanding of the introspective methods; and for that reason emphasis has been laid upon the difference between description and explanation. We have now to take account of a fact that renders their confusion, in psychology, as natural as it is dangerous: the fact that there may be a descriptive psychology of logical operations. Münsterberg prefaces his account of psychological method with the remark that "every investigation set on foot by a special science presupposes the universal logical functions, and no psychological method can yield its full fruit whose user fails in ability to form judgments, concepts, inferences, to develop his thoughts inductively and deductively, to formulate classifications and demonstrations."[84] That is the side of the shield to which we have so far given our attention. But Ward's statement is equally true,—that "'the whole choir of heaven and furniture of earth' may belong to psychology;"[85] the domain of psychology is as wide as individual experience. While, then, psychology presupposes logic, it may also consider logic from its own point of view; it may, in particular, furnish an introspective account of the content-processes that correspond to logical operations.

I said that this fact makes it natural for the psychologist to confuse description and explanation, fact and meaning. For, on the one hand, it tempts him to hypostatise the abstractions of logic; to invent content-processes of relation, of judgment, etc., and in this way to secure

[83] C. H. Judd, What is Perception? *Jour. Philos. Psych. Sci. Meth.*, vi, 1909, 41. The italics are mine.—To prevent a possible misunderstanding, I will here state explicitly that I hold no brief for sensation, and do not aim to reduce the content-processes of descriptive psychology to the type of sensation. If the advocates, *e. g.*, of the thought-element can demonstrate a new content-process, I am ready to accept it. More than this: I sincerely welcome any phenomenological term or phrase (such as 'conscious attitude') that challenges to psychological analysis. I note a challenge of this sort in the 'purely dynamic process' found by M. Wertheimer in his recent study of seen movement (*Zeits. f. Psych.*, lxi, 1912, 245).

[84] *Aufgabe und Methoden*, 145. Wundt says the same thing in his essay Ueber psychologische Methoden, *Philos. Studien*, i, 1883, 3; cf. Die Aufgaben der experimentellen Psychologie, *Essays*, 1906, 206 f.

[85] *Op. cit.*, 548.

a phenomenological agreement of psychology and logic.[86] And, on the other hand, it may blind him to real psychological problems. There will, for instance, be few psychological descriptions, of any length, in which the term 'greater,' or some more specific equivalent, does not occur. We are so much accustomed, in adult life, to the comparative form of the adjective, that this 'greater' may well pass for a descriptive word. Yet in strictness it is, as psychophysical usage rightly declares, the expression of a judgment of comparison; so that the psychologist who accepts it as part of the currency of description overlooks one of the problems that is set by logic to psychology.[87]

Recapitulation.—We asked the question: What are the categories of psychological description? or: What is consciousness as describable object? The foregoing paragraphs touch, in the barest way, upon the points which arise as we seek to answer this question. Descriptive psychology must begin with analysis, because analysis is the first task that a given subject-matter assigns to science. The terms of description must be content-processes, because consciousness proves, as we observe it, to be made up of content-processes. At any stage of description, we may bring logic to bear upon our introspective material; but we must not read logic into that material. Finally, a set of accurate descriptions of typical consciousnesses is not a system of psychology; yet, if we may judge by history, there is no short cut to system that avoids the minutiae of description: and while we should make all allowance for differences of temperament, and should recognise every honest effort to further the understanding of mind, we must neither mistake temperamental impatience for reasoned argument nor tire of plodding the low *posteriori* road of observation.

4. *The Introspective Method as applied to Thought*

At this point of the enquiry, it seems advisable to put our conclusions to a practical test. Experimental introspection, we have said, is a procedure that can be formulated; the introspecting psychologist can tell what he does and how he does it. If, now, we seek to formulate the method, in a concrete case, we shall be the better able to judge the value of Müller's schema; we can make such additions and qualifications as may prove to be necessary; we pave the way for

[86] Stratton (*op. cit.*, 81) rightly complains that "relational elements, feelings of relation and the like are often in effect conceived as but one more material or ingredient added to the rest." When he adds, however, that "the account then pursues the evil course of describing a mental fact by attention to its stuff and materials only," he seems to me to miss the point of his own objection.—The same protest against hypostatisation of inferences forms a *Leitmotif* of Judd's essay on Perception, to which I have referred above.

[87] The problem overlooked is in fact twofold, descriptive and genetic. For the psychologist must not only describe the content-processes which, in the particular case, are the vehicle of the judgment; he must also trace the course of development from 'absolute impression' to true 'comparison.'

a detailed consideration of sources of error; we shall perhaps be able to detect and to eliminate spurious forms of experiment. And there are obvious reasons why the processes of thought should furnish the illustration required. I take the investigations in the order of their appearance.

(1) Marbe, in his study of Judgment, makes the method very simple. In order to experiment upon judgment, "one has merely to bring it about that the observer experiences the kind of judgments required, and to ask him to describe his experiences (*Erlebnisse*) immediately after the judgments." Thus, in a special case, the observer "had at once to report (*zu Protokoll geben*) the conscious processes which he had experienced" when the conditions for judgment were completed; moreover, "he was asked not to confine himself, in his description, to the processes that ran their course simultaneously with the perceptions which took on the character of judgment,—since it might possibly be of interest to know what conscious processes introduced the act of judgment."[38] Nothing more is told us. But we may, I think, infer from Marbe's introduction, and from the wording of the reported introspections, that the observers undertook their task in a definitely psychological spirit: a phrasing of experience in familiar psychological terms seems to have been expected by the experimenter and intended by the observers.[39]

(2) Watt, it will be remembered, has six problems, which are formulated in the ordinary logical way: to find a superordinate, subordinate, coördinate concept, and to find a whole, a part, another part of a common whole. He says very little of his method.[40] "After every experiment, the observer reported everything that he had experienced and everything that he cared to say about his experiences. All this was at once written down by the experimenter, and was occasionally supplemented by appropriate questions." "The report depends upon the observer's conscious contents, which he described and expressed in words as quickly as might be."[41] Watt's aim was rather explanatory than descriptive; and he therefore appears to have preferred a phe-

[38] K. Marbe, *Experimentell-psychologische Untersuchungen über das Urteil: eine Einleitung in die Logik*, 1901, 93, 16, etc.

[39] Cf. Marbe's later statement: "I have supposed that what is done in these experiments is, in general, to bring out in the observer, by fitting prearrangements, experiences of some particular kind, and then at once to evoke judgments regarding these experiences" (review of E. Dürr, Erkenntnistheorie, *Zeits. f. Psych.*, lx, 1911, 121 f.). A complete account of introspective procedure demands, in Marbe's opinion, "a thorough-going, many-sided, perhaps somewhat tedious experimental enquiry" (*ibid.*).

[40] H. J. Watt, Experimentelle Beiträge zu einer Theorie des Denkens, *Arch. f. d. ges. Psych.*, viii, 1905, 289 ff. Inferences may be drawn from the sections 316 ff., 332 f., etc.; but I am here concerned only to discover how the author himself conceives his method,—not to interpret the observers' reports. Interpretation, if it is to carry conviction, must be based on a special experimental study, like that of which Marbe speaks.

[41] *Ibid.*, 289, 423. Cf. 426: the report, in psychological experiments, is not exhaustive.

nomenological to a strictly psychological report.[42] There is, undoubtedly, a change of attitude, as one passes from Marbe to Watt.

(3) The aim of Ach's method of 'systematic experimental introspection' is to secure "a complete description and analysis" of the experimental consciousness. The observer is instructed "to give in the after-period a detailed description of the processes experienced in the fore and main periods;" the intent to observe thus bears upon the contents of the after-period, and helps to throw them into clear relief, while it does not interfere with the consciousness of the two preceding periods. The ideas of the after-period are conditioned upon perseverative tendencies; they are not memory-images, but rather memory after-images; they may remain clear for several minutes. "At the beginning of the after-period, the observer frequently has a peculiar consciousness of what he has just experienced. It is as if the whole experience were given at once, but without a specific differentiation of contents. The entire process is, as one observer put it, given as if in a nutshell. The particularities of the process then emerge, clear and distinct, from this matrix. . . . The attention may be turned now to this now to that part of the perseverating contents, so that the simultaneous and successive portions of the experience can be subjected to a thoroughgoing analytical dissociation and description." Completeness of report is further guaranteed by question and answer; there is "a continual and intimate exchange of thoughts between observer and experimenter;" "the experimenter plays a more prominent part than in any other psychological method."[43] However, as practice increases, and

[42] Cf. 345, *note* 2, where an observer is taken to task for reporting in terms of a systematic psychology; and the section on the insufficiency of consciousness, 423 ff.—I select some typical remarks. (1) It is dangerous to argue from absence in report to absence of conscious contents. For there may be nothing present in consciousness, at the moment of introspection, to reproduce the particular experience; or what is present may simply be unable to reproduce it; or the *Aufgabe* of description, though operative, may not be sufficiently active; or the observer may not have reported all that he might have reported: 427. (2) Relations and delimitations are not given, as such, for description; their report demands special *Aufgaben* of explanation and comparison: 428 f. (3) Current 'descriptions' of certain higher processes are largely colored by theory, or have been made up in accordance with probabilities: 435.

[43] N. Ach, *Ueber die Willenstätigkeit und das Denken*, 1905, 8 ff. The following points may also be noted. (1) Perseveration is favored by attention, practice, and intent to observe: 10 f. (2) Both observer and experimenter must strive for completeness of description; the experimenter must therefore keep close watch upon the forms of expression used by the observer: 13 f., 16. (3) Disadvantages of psychological observation are: the need of a constant control of the terms of report, if description is to be adequate; the necessary assumption that a perseverating experience is identical with its original; the difficulty of reëstablishing exact conditions; the very great difficulty of complete description: 15 f., 16 f., 20. (4) Great care must be taken that questions put by the experimenter are not suggestive: 17 f. (5) Temporal order must sometimes be sacrificed, in order that transient processes may be grasped and analysed: 19. (6) Practice favors description; so that part-processes which received but little attention in the original experience may stand out in the perseveration: 19 f. (7) Defects of the method of systematic experimental introspection, in its

the observer's vocabulary becomes fixed and precise, this feature of the method loses in importance."[44]

Müller criticises the method thus described by Ach on four principal grounds. It is, he says, dangerous, for several reasons, to have free recourse to question and answer. It is out of the question that the introspective report of a fairly complicated consciousness should be even approximately complete. The perseverative tendencies are selective and, at times, misleading; and we have no proof that they are strengthened by the intent to observe. Finally, it is dangerous to suggest to the observer that the contents of the after-period are identical with those of the experimental consciousness; we know of cases to the contrary; and the observer should therefore be instructed to report only such experiences as he remembers, with assurance, to have occurred during the experiment.[45]

present form, are: unequal duration of experiments, and of interval between experiments; occasional disturbance of an experiment by the after-effect of a foregone analysis: 22 f. (8) A control of introspection by variation of external conditions is essential: 16, 20 f., 25.

[44] *Ueber den Willensakt und das Temperament*, 1910, 7 ff. Questioning is necessary so long as observers are unpractised and terminology is unsettled; under the most favorable conditions, it "retires wholly into the background:" 8 f. Ach's 'awareness' (*Bewusstheit = Gegenwärtigsein eines unanschaulich gegebenen Wissens*) was discovered by questioning: "erst durch das Eingreifen des Fragen stellenden Versuchsleiters wurden diese Erlebnisse aufgedeckt und dann bei jeder Versuchsperson nachgewiesen." For the rest, questions cannot be harmfully suggestive if the method of systematic experimental introspection is given an experimental setting "which permits a quantitatively variable graduation of the causal conditions and a genetic-synthetic construction of the phenomena:" 9, 15, 17.—Ach again insists on completeness of analytical description, and urges that fractionation (Watt, *op. cit.*, 316 ff.) must be applied with great caution: 11.

[45] G. E. Müller, *op. cit.*, 137 ff. A. Michotte recognises that "the data of memory are fatally incomplete," but thinks that the experimental conditions are, nevertheless, extremely favorable to reproduction. He believes, with Müller, that "questions like those put by Ach are not allowable" (A propos de la "Méthode d'Introspection" dans la psychologie expérimentale, *Rev. Néo-Scolastique*, iv, 1907, 522 f., 525 f.). G. Deuchler criticises both the demand for complete description and the use of questions. Not only is questioning dangerous; it is also, at the best, of little value; for it increases the number of analytical results without enhancing the delicacy of analysis (Beiträge zur Erforschung der Reaktionsformen, *Psych. Studien*, iv. 1909, 380 ff.). These references are given by Müller. E. Westphal defends Ach's method: a 'complete' report means simply a non-selective report, an account of all that the observer can remember; and questions, dangerous as they are, are still under certain circumstances unavoidable (Ueber Haupt- und Nebenaufgaben bei Reaktionsversuchen, *Arch. f. d. ges. Psych.*, xxi. 1911, 432 ff.). Reichwein, on the other hand, anticipates much of Müller's criticism. Questioning is always dangerous (*op. cit.*, 77); reports are almost inevitably incomplete (58, 110, 133); the play of attention upon perseverating contents may introduce personal interests and prejudices (76). Reichwein points out that Ach's nutshell revival is a *Bewusstheit*, an awareness (103); and a comparison of the relevant passages in the *Willenstätigkeit und Denken* (11 f., 210 f.) confirms the remark; the after-period opens with a *Bewusstheit*,

(4) Messer gave his observers a long series of problems, some of which called for thought of 'objects,' and others for thought of 'concepts.'[46] The observers were instructed, "as soon as they had uttered the reaction-word, to report everything that they had experienced from the appearance of the stimulus-word up to the moment of reaction." Questions were employed but sparingly, and with care to avoid suggestion.[47]

Messer is expressly concerned with the nature of the introspective procedure; he wishes to discover "what is actually going on in the observer while he makes his report." "The observers were often required, at the end of their report of an experience, to state what they themselves had experienced while they were giving the report." He finds two main types of description. In some cases, "the experience just had is past, of course, and yet in a certain peculiar sense is still present; it is, so to say, arrested for examination;" here we have Ach's perseveration, or Lipps' direct recollection. In other cases, there is need of 'reflection;' the experience is 'reproduced' for examination; here we have Lipps' indirect recollection. Between these stand intermediate cases, in which recollection is direct, but reproductions "appear as it were of their own accord, as concomitant phenomena."[48]

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out of which the 'perseverating ideas' are explicated. But how then does Ach know that these ideas are really 'perseverative,' and not an imaginative reconstruction on the basis of the awareness? Finally, Wundt, writing in the same year as Michotte, passes negative judgment on Ach's use of questions (Ueber Ausfrageexperimente und über die Methoden zur Psychologie des Denkens, *Psych. Studien*, iii. 1907, 338 ff.). "Eine Frage ist an und für sich eine Beeinflussung, sie mag so vorsichtig wie möglich eingerichtet sein. . . . [Der Fragende] mag noch so vorsichtig sein, nach irgend etwas muss er doch fragen."

[46] A. Messer, Experimentell-psychologische Untersuchungen über das Denken, *Arch. f. d. ges. Psych.*, viii, 1906, 4 ff. I have already noted the logical formulation of Watt's problems; I note here that Messer's distinction seems calculated to bring in the stimulus-error. "This distinction is meant, of course," Messer says, "to carry a psychological meaning simply; the differences to which it points are differences merely in the thought-experience:" 149. That the differences are not psychologically self-evident is proved, however, by the fact that "not all observers were able to perceive them:" 150.

[47] *Ibid.*, 12.

[48] *Ibid.*, 14 ff.; T. Lipps, Bewusstsein und Gegenstände, *Psych. Untersuchungen*, i. 1905, 39 ff.; *Leitfaden der Psychologie*, 1906, 12 ff., 42 ff. Messer's treatment is schematic: we are not told, *e. g.*, whether the reproductions of the mixed cases are used for the purpose of description, or serve as a check upon the description of the more stable memory after-images, or are just ignored.—The observer's knowledge that he has to report is, in general, favorable to fullness of statement: 17 ff. On this point, Messer furnishes, in Ach's behalf, the evidence that Müller finds to be lacking. Messer, however, has nothing to contribute to Ach's theory of perseveration; his references are to Lipps.—One observer reports: "When I make these statements, the experience (*das Erlebte*) is not always reproduced, though it often comes to that. It is a curious fact that, if statements of this sort have not suggested themselves (*sich bereit gestellt*) at the time of the experience (*mit dem Erlebten*), we know nothing whatever about it:" 16, 21 f. Yet the same observer declares: "There is no actual introspection during the experiment." I have discussed this report in *Thought-processes*, 1909,

(5) Bühler, like Watt, says little of his method. He demanded from his observers "a description, as accurate as possible, of what they had experienced during the experiment." No emphasis was laid upon completeness of report; it was rather desirable that the observers "should give a good account of what, in the particular case, they had seen with especial clearness and knew with perfect assurance." Nor was there any restriction of terms; the observers were allowed to choose their own words, and sometimes were expressly warned against the use of technical expressions. The method requires the intimate coöperation of experimenter and observer; but the coöperation is not secured, as with Ach, by much questioning; questions are employed only under stress of necessity; it is secured rather by empathy, by sympathetic understanding.[49]

So much Bühler volunteers. When the charge of *Kundgabe* and *sprachliche Darstellung* has been laid against him, he admits that "many parts" of his reports are not descriptive; but "one must not forget," he adds, "that I was obliged to report a great deal simply in order to show the connection in which the essential portion of the record stood."[50]

(6) The results of the series of studies published from the Cornell Laboratory[51] may be summarised as follows. First, there can be no doubt that direct memory (Ach's perseverating contents, Fechner's memory after-images) plays a part in the reports. In general, however, this part is intermittent: that is to say, a certain passage of the original experience will reappear in the after-period in direct memory, while the passages that precede and follow are reproduced in the ordinary way. We have never had any clear instance of Ach's total reinstatement. And it seems that the passages which thus stand out, in direct memory, are always passages which, in the original experience,

239; I mention it here only to emphasise the slipperiness of methodological terms. It is plain that the 'suggestion' was conscious, or the observer could not have reported it.

Reichwein argues that direct recollection can hardly play any large part in investigations of this kind, since thought is teleological and shoots to a conclusion, with the result that the intermediate steps quickly fade from consciousness: *op. cit.*, 40, 110, 115 f., 150 f. He finds in this fact the critical justification of Wundt's second rule of experiment: *Psych. Studien*, iii, 1907, 308.

[49] K. Bühler, Tatsachen und Probleme zu einer Psychologie der Denkvorgänge. I. Ueber Gedanken, *Arch. f. d. ges. Psych.*, ix, 1907, 299, 305; 307 f.; 309, 331; 308 f., 313. Bühler finds an 'objective control' of the method in the immanent agreement of the reports and in the results of his experiments upon the memory of thoughts: 306 f. Reichwein thinks that the agreement of reports is, in such cases, inconclusive; the setting of the tasks and the phrasing of the instructions carry a suggestion from the experimenter: *op. cit.*, 56, 67, 74. Only where there is a truly objective control, by time-measurements and by variation of experimental conditions, is the agreement to be trusted: 77. Reichwein also expresses his lack of confidence in empathic interpretation of the reports: 109.

[50] Zur Kritik der Denkexperimente, *Zeits. f. Psych.*, li, 1909, 118; cf. *op. cit.*, 318.

[51] I do not give a list, as all have been printed in this JOURNAL. I have read a number of other articles upon Thought and Volition, all in fact that I could discover, but I have found nothing else of importance that bears on the conduct of the method.

had been 'marked' for report.[52] I cannot, however, affirm that there are no exceptions to this rule.[53]

Secondly, there is a tendency, apparently universal, to help out description by formulation of meaning. The tendency is exceedingly strong in the case of relatively unpractised observers. As practice advances, the mode of recall varies. Sometimes (and this is, perhaps, the ordinary procedure) meanings and content-processes alternate; the 'marked' passages of the experience are described, unmarked passages are summed up in a statement of meaning. Sometimes the observer takes his bearings, so to say, in terms of meaning before he begins to describe; the schema of meaning then serves as a support to, and as a check upon, the course of reproduction.[54] Sometimes, again, if reproduction fails at a given point of the report, the observer will hark back to meaning, and will reconstruct in imagination the content-processes of the original experience: this recourse is not common, but it has unquestionably occurred.[55] And sometimes the observer will deliberately turn away from meaning, and will set himself to report in the terms of descriptive psychology.[56]

Our experimenters differ as to the legitimacy of appeal to meaning; and such differences of opinion, where the whole method is still crude and imperfect, are only natural. They differ also, thirdly, as regards the propriety of questions. On the whole, I think, we have come to the conclusion that questioning is dangerous; and that, if a special point needs to be cleared up, it is better to work by way of variation of experimental setting and material. At all events, results obtained by questions should be sharply marked off from those derived from the spontaneous report of the observers.[57]

It is evident that these accounts are meagre; it is evident, too, that they contain an unsifted mixture of fact and theory, of exposition and valuation. But let us remember that we are dealing with a method in its formative stage, and that our own present question is not whether the method is valid, but

[52] A term which has become current in the laboratory for the 'marking' of a conscious complex by a practised observer is 'nodding to:' "I nodded to that as it came." Here we have a 'psychological apperception' reduced to very low, if not to lowest terms.

[53] The rule may not be inverted: not all 'marked' passages recur in direct memory.

[54] This preliminary orientation by meaning may, perhaps, correspond to Ach's nutshell reproduction, which, as we saw, is a *Bewusstheit*, and not a reproduction in kind.

[55] Müller's *nachprobierendes Vorstellen: op. cit.*, 96.

[56] Including, in this case, the terms of the Würzburg school.

[57] Ogden and Dodge (see this JOURNAL, xxiii, 1912, 438) must, I imagine, have overlooked the fact that Ach's *Bewusstheit* was discovered by questioning on the part of the experimenter. Ach himself does not think it necessary to make this statement, explicitly, in the *Willenstätigkeit und Denken*, though he comes near it (*e. g.*, 17, 41 note). At the other extreme stands the author of a recent article upon Feeling, who made many experimental observations upon his topic, but has preferred to say nothing about them, and simply to set forth his own theoretical convictions, because the confirmation received from his observers was gained by possibly suggestive questioning.

whether it can be formulated. We shall then find the scarcity of detail and the confusion of standpoints pardonable; and we shall realise that—whatever the prepossessions of the experimenter, and whatever the aberrations of the observer—the procedure followed can be pretty definitely stated. One gets the impression, indeed, that the experimenters, or at least the earlier of them, took the introspective method for granted: they were setting a straightforward task, which the trained observer was competent to perform. The event shows, of course, that the observer is as resourceful in going astray when the thought-processes are under observation as he is in other and better-known fields of experimental work; it shows also that the conduct of the method by the experimenter is by no means a simple matter. This insight, however, has itself depended, in no small measure, upon the communication of the method by those who have employed it; had their accounts been unintelligible or seriously inadequate, criticism must have remained general, and the detection of particular sources of error would have been impossible. The method of systematic experimental introspection, to return to Ach's phrase, has never been set down with the fullness to which we are accustomed in the case of sensation, of after-image, of perception, of memory, etc. And, in so far as this fullness of statement implies the establishment of norms, of definite rules and regulations for experimenter and observer, we must freely grant that, in the sphere of thought, it is as yet unattainable. Yet there can, surely, be no doubt that the practice of the Würzburg school is, in principle, communicable and that the formularies of introspection will some day be as exact for the more complex as they now are for the simpler content-processes.

Meanwhile, a host of questions is upon us. Are the experimental thought-consciousnesses 'free' consciousnesses in Müller's sense, or are they in any sense dependent upon the intent to observe? What is the effect of this intent to observe, in all the various forms that it may take and in all the various settings in which it may appear? May the non-observational methods, such as those of imaginative reconstruction and of communication,—may these non-observational methods be employed, under any circumstances, or must they be strictly forbidden? What are the marks that distinguish direct from indirect memory? What are the lowest terms of a psychological apperception? May it, like the *Aufgabe*, lapse with time into the unconscious? When, if at all, may the experimenter have recourse to questioning?

Questions, these, of very different range; and questions that, in the present state of our knowledge, admit of answer in very varying degree. Many of them have been discussed by Müller, in the work to which we have frequently referred: and the reader may be heartily recommended to that discussion. Some of them I hope to take up in a later paper.

Summary.—There are specific differences of introspective procedure, but all the forms show a generic likeness; introspection always presupposes the point of view of descriptive psychology, and the introspective methods thus do us the same service in psychologising that 'observation and experiment' do in natural science. The generic likeness of procedures allows us to write a general formula for the conduct of introspection; and a strict adherence to the descriptive standpoint allows us to determine the objects of introspection as content-processes. A tentative application of G. E. Müller's formula to the recent experimental work on Thought and Volition confirms the results of the foregoing theoretical discussion, while at the same time it raises a number of further methodological questions.

NEW APPARATUS FOR ACOUSTICAL EXPERIMENTS[1]

By M. Bentley, E. G. Boring, and C. R. Ruckmich

Sound-Localisation Apparatus

(Fig. 1)

While this apparatus was originally designed and built for the purpose of localising pure tones, it is, nevertheless, suitable for localising noises as well. It consists, first, of a rod (*a*) of ½″ gas-piping, bent to an arc of 120 degrees of a circle 3 feet in radius. This rod is fitted into a vanadium steel plate, shown at (*b*), which moves noiselessly and readily on a ball-bearing runway above and below it and between two stationary steel plates (*c* and *d*) of the same diameter (4 inches). All three plates are fastened together by means of a bolt, seen at *e*, ¾″ in diameter and 6″ long, which screws into an angle-plate (*f*) above it. A lock-screw holds the bolt in place. The angle-plate fits the lower end of a 4″ x 6″ beam (*g*) that reaches to the ceiling of the large room in which the apparatus stands. On the revolving plate which carries the curved rod is fastened a brass disc (*h*) 1/16″ thick and 6″ in diameter. Upon this disc are painted in black on a background of white enamel marks which indicate in degrees of rotation the position of the curved rod in the horizontal plane. A blued steel pointer fastened on the lower stationary plate gives the precise reading. Along the curved rod (*a*), which is also marked in degrees of position in the vertical plane, is fastened a movable and adjustable coupling (*i*). This coupling allows a brass rod (*j*) ⅜″ in diameter and 4′ long, to move radially in and out from the arc and at right angles to the tangent of the arc at that point. The coupling with its brass rod can also be placed in any position on the curved arc; *i.e.*, it can be placed anywhere along the circumference of the circle in the vertical plane. On one end of this brass rod an adjustable clasp (*k*) is fastened. The clamp is primarily designed to hold an electrically operated tuning fork and re-

[1] From the Psychological Laboratory in Arts, Cornell University. With the exception of the pendulum-control for the rhythm-box and a part of the interruptor, fashioned by Mr. Ruckmich, the pieces described have been made from the Department's plans and models by Mr. C. N. Harding, of the firm of Messrs. Kellogg & Harding, 108 North Cayuga St., Ithaca, N. Y.—M. B.

sonator, indicated at *l*, but may hold any other electrically driven device for the production of sound. One electric connection is made with the fork through the metal frame of the apparatus, the other through a flexible lamp-cord to a wheel contact (*m*), moving along an insulated track at the bottom of the supporting beam. This method of connection obviates the difficulty of twisting the connecting wires as the apparatus rotates. Both the weight of the fork and the weight of the revolving curved rod are suitably counterbalanced by means of adjustable counterweights (*n* and *o*). The observer sits in a cushioned chair with his head in a head-rest, seen at *p*. His ears are approximately at the center of the circle of which the curved rod forms an arc, and opposite the open end of the resonance-box. The varying height of observers is accommodated by raising or lowering the chair. In front of the observer's head is mounted a 4 c. p. incandescent light (*q*), seen through the closed eye-lids and operated by the experimenter as a 'now' signal. The connections from the fork pass along the ceiling, and from the signal light through a socket in the floor, to a writing desk (*r*), equipped with a shaded reading-lamp and two switches, one for the fork and one for the signal light. The desk is over nine feet from the observer and the switches mounted on it are noiselessly operated by the experimenter. The connections pass on to an adjoining room separated from the experimenter's room by a stone wall two feet in thickness. In this adjoining room, a Helmholtz exciting-fork electrically driven is set up. It is connected in shunt circuit with the secondary fork and has a vibration rate two octaves below the secondary fork. It was necessary to connect it in a shunt circuit because it was inconvenient to pass into the adjoining room to start the exciting-fork after the operating switch was pulled at the end of every judgment.

The apparatus has, among others, four advantages: (1) it makes possible experimentation with a pure tone, and the avoidance of various secondary criteria, viz., rustling of experimenter's clothing, noise of footsteps, sounds from breathing, etc.; (2) it covers every advantageous point in the tridimensional manifold, because the fork can be moved in and out with regard to the observer's ear from proximity to a distance of about six feet;—this outer limit is reached by swinging the brass rod, which carries the fork, around outside of the curved rod that marks the circumferential boundary of the three-foot circle; (3) on account of the noiseless bearing above, where the apparatus is attached to the supporting

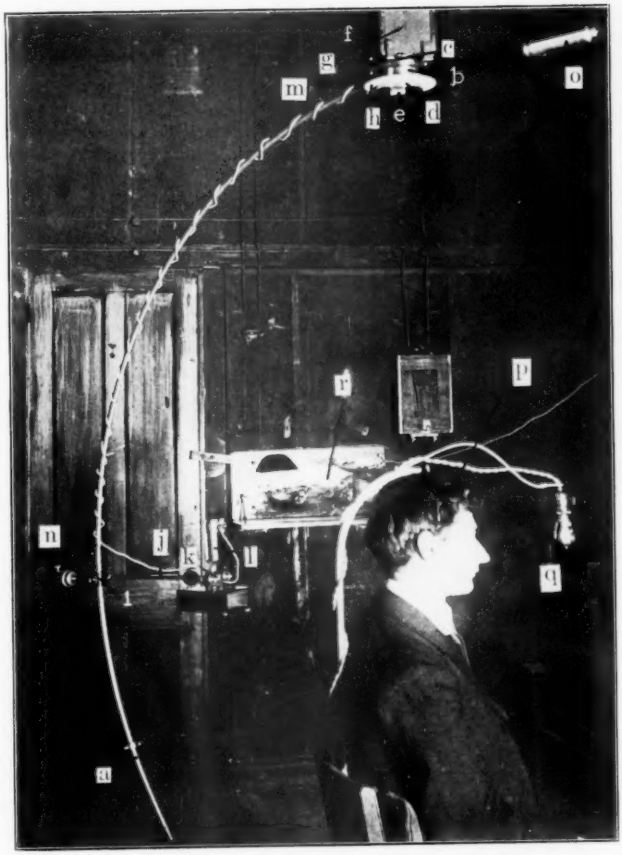

FIG. 1.—Sound Localisation Apparatus.

beam, and because of the impossibility of twisting the circuit wires during rotation, it is suitable for experimentation with a moving stimulus; and (4) inasmuch as there is no mechanical connection with the chair and head rest, disturbances attending the adjustment of the apparatus are not communicated to the observer.

Rhythm Interruptor

(Fig. 2)

This device is a part of the general apparatus used in an investigation of the rhythm-consciousness. It was designed to interrupt the secondary (receiver) circuit of a telephonic system. The demands upon the apparatus were eight in number: (1) The apparatus should rotate at a constant rate of speed, (2) its speed should be variable at the experimenter's wish, (3) its speed should be easily measurable, (4) the apparatus should produce a rapid interruption of a telephonic circuit, (5) during intervals between interruption, there should be the best possible electrical contact, (6) there should be a simple and accurate method of varying the temporal length of intervals of contact and of non-contact, corresponding to the length of members and of pauses between members of a rhythmic series, (7) these periods of contact and of non-contact should be subject to accurate measurement, and (8) both long and short intervals, *i.e.*, those between groups of members and those between members of a rhythmic series, respectively, should be of constant temporal length, regardless of the change in the duration of the individual members of the rhythm. To meet the first requirement, we used an Edison electric phonograph motor, whose speed is regulated by means of a governor as indicated at *d* in Fig. 2. When the speed of the motor tends to increase, this governor introduces a resistance into the circuit and does not break the circuit as is the case with the Helmholtz motor.

At *e* is shown a slide-rheostat by means of which the speed of the motor is regulated in accordance with the second demand. The constancy of speed of rotation is satisfactory for the periods employed. The mean variation for 17 determinations covering a period of 11 minutes was calculated to be .9%. Upon the steel cylinder of the phonograph-record, whose end is seen in the upper left corner of the engraving, is mounted a belt-groove. This groove affords a tight grip for the belt and keeps the belt in place on the cylinder. The belt runs over a pulley which is fastened on a spindle at the

forward end of which are seen the two overlapping cams, *a* and *b*, held in position by means of a knurled nut. This spindle is mounted on a base separate from the motor. The cams are made of 1/32″ sheet brass, and can be readily replaced by any other type of cam desired. These cams serve as a basis for the interruption of the secondary circuit and for the consequent production of the two-membered rhythm investigated in this experiment. At *c* is seen the lever made of amalgamated sheet copper. This lever is tripped by the cams. To its right is a duplicate lever which may be used when another circuit is to be interrupted in alternation with the first. In this case another arrangement of the cams used becomes necessary. As the cams are shown, *b* is mounted in front of *a* which is approximately a sextant and carries on its circumference a black pointer seen directly above lever *c*. This pointer indicates, upon the graduated arc *b*, the amount of revolution of *b* over *a*. The cams are cut to give a long interval of 180° shown in the upper circumference of *b* and a short interval of 60° represented by the arc of *a*. On either side of *a* as shown and, of course, uniting in front of the arc of *a*, are depressions corresponding to the two members of the rhythm, *i.e.*, stated a little differently, the lower circumference of *b* is a continuous depression, interrupted by the projection of cam *a*. To whatever extent, therefore, *a* is rotated to the right or to the left over the circumference of *b*, to that extent will the temporal rhythm become iambic or trochaic. At the position shown, the rhythm delivered will be approximately a spondee. In this way is the sixth requirement met. The lever dips into a mercury cup, shown beneath it, whenever a depression occurs in the circumference of the cams. This sort of contact is, of course, one of the very best obtainable and meets the fifth condition. In like manner is the fourth requirement satisfied, because, as the cams in their rotation very quickly act upon the shorter arm of the lever, the more quickly is the longer arm lifted out of the mercury. The eighth demand is satisfactorily met by the shape of the cams themselves. Both outer circumferences of these cams are of constant length regardless of their shifting. The requirements as to the accuracy of the measurement of the speed of the motor and the length of the intervals of contact and of non-contact are adequately met by putting in series with the circuit interrupter an electric time-marker together with a time-fork, or other recording apparatus, and a kymograph, or the Hipp chronoscope. There is ample provision for inserting another circuit in which the

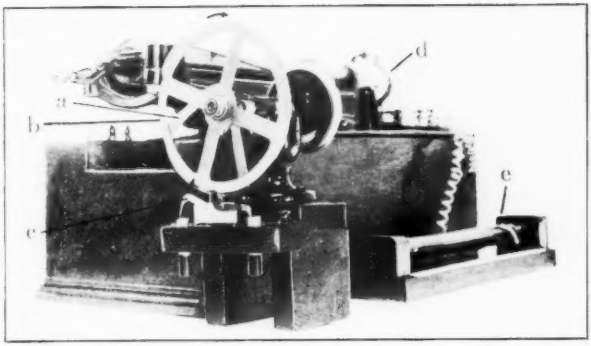

Fig. 2.—Rhythm Interruptor.

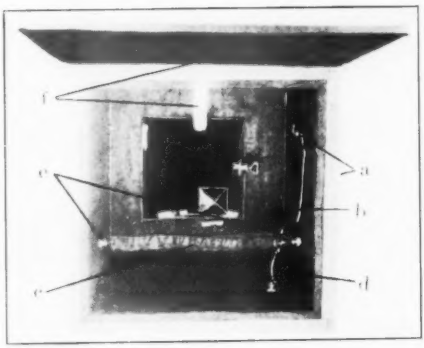

Fig. 3.—Rhythm Box Controller.

second lever may be used, as when a circuit of comparatively high resistance is to alternate with one of less resistance in order to obtain a difference in the intensity of the two rhythm members, or as when a circuit connecting with a source of sound of higher pitch is to alternate with a circuit connecting with a source of sound of lower pitch, in order to obtain differences in pitch between the two members. By the addition of the proper number of cams and by inserting cams of the proper shape, rhythms of a higher order than the two-membered series used in this experiment may be produced.

Rhythm-box Controller

(Fig. 3)

In order to produce an unintensified sound at the beginning of a rhythm series after an interval of no sound by means of a Stoelting rhythm-box, it became necessary to modify the apparatus in the manner shown in Fig. 3. As the apparatus is put on the market, it consists of a square felt-lined box, high enough to contain an ordinary metronome and wide enough to allow the metronome pendulum to execute its widest excursion. The cover of this box is hinged at the back and it is opened slightly and noiselessly by means of a series of connecting rods and a finger-key. After the metronome is started in the box and the cover is closed, a faint ticking is heard until a depression of the finger upon the key raises the cover and intensifies the sound. If, then, there is occasion to start the rhythm series with an unintensified metronome click after an interval of no sound, or if it becomes necessary or convenient to start and stop the metronome clicks at any desired points in the rhythm series, recourse must be had to a device that will start and stop the metronome when the cover is closed.

The view in the photo-engraving is from above. The metronome stands on a piece of heavy harness-felt in which a triangular hole is cut to receive the three feet mounted on the base of the metronome, thus to insure the accuracy of its position. In front of the pendulum is a padded brass rod (*c*), pivoted at *c*, in shape like the wire of a long package-handle. At the right before it bends down to its pivot, a steel tension spring (*d*) is attached and fastened in the same plane to the front side of the box. At this place, also, is pivoted a rod (*b*) which connects the padded brass rod (*c*) with the operating lever (*a*). This rod (*b*) is bent to the right to avoid interference with the swinging of the metro-

nome pendulum. The operating lever (*a*) passes through the side of the box and pulls against the spring (*d*). When moved toward the back of the box, it causes the padded brass rod (*c*) to press against the metronome pendulum, and when given an additional downward thrust past its own 'dead-center' it locks the device. At *f* is indicated a rubber-covered steel spring and protecting pad. These are attached to relieve pressure and to avoid the noise of the dropping cover.

The entire device proved to be noiseless in operation and in other respects very satisfactory to the experimenter during months of continuous use. With practice the experimenter was able by its means to stop the pendulum at the end of its swing so that it started properly in response to the mechanism of the metronome when the operating lever (*a*) was released.

CHRISTIAN A. RUCKMICH.

Rhythm Hammer

(Fig. 4)

This piece is adapted to drill and demonstrational purposes. It is made up of a steel hammer and anvil, a set of adjustable cams for producing various rhythmic patterns, and a friction speed-gear. The frame is 13½ in. x 19 in. x 7½ in. It has cast-iron sides and steel cross-bars, and it is securely set upon a heavy 3-ply oaken base. A longitudinal shaft, fitted to the centre of the friction-wheel, accommodates as many as nine cams. The cams are slipped into the key-way of the shaft by removing two knurled set-screws which hold the end cross-bar (*a*). Any one of them may be instantly adjusted in the plane of the hammer and thus set into action. The height of fall of the hammer is provided for by two or more radial drops cut in the cam; *e.g.*, a simple 2-rhythm is produced by one high and one low drop set at opposite ends of a diameter, a simple 3-rhythm by one high and two low drops spaced at 120°. Since the hammer may be released (by withdrawing a bit of felt from the anvil-head) upon any beat of the rhythmic unit, two cams suffice for the five primary rhythms. The other cams are reserved for special stimulus-patterns. The apparatus provides, moreover, for a universal cam fitted with slotted eccentric arcs for the production of small temporal and intensive variations. (This cam is not figured.) An adjustable coiled spring (*b*), which fastens the hammer-rod to its forked steel support, determines the general intensity of the pattern. Since the anvil (*c*) and the hammer-support (*d*) are alike capable of

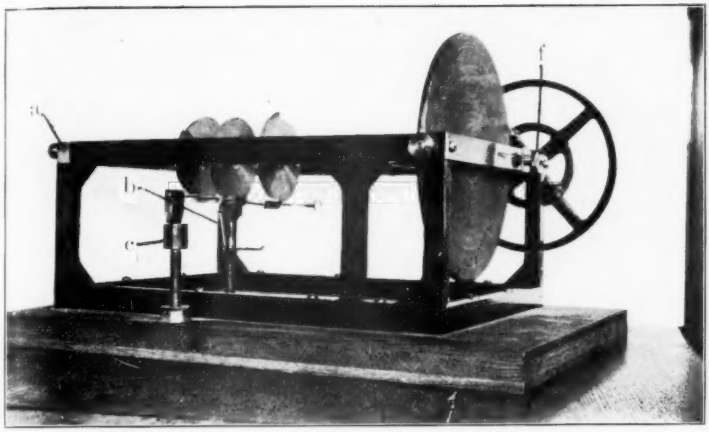

Fig. 4.—Rhythm Hammer.

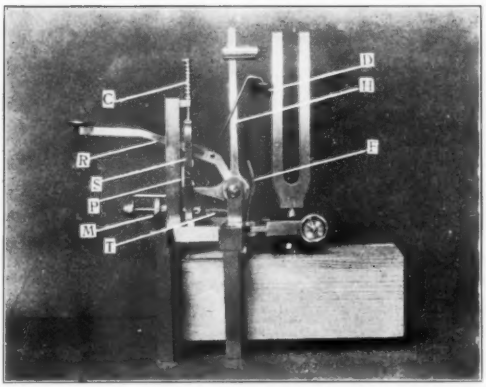

Fig. 5.—Automatic Tuning-Fork Hammer.

vertical adjustment, cams of various diameters may be used. The tail-piece (*e*) of the hammer-rod is made of fibre to eliminate the noise of contact with the brass cams. The friction-gear and the double pulley-wheel together allow for a variation in speed within the limits 1 to 8. The setting of the drive-wheel against the friction-plate is indicated by a scale-bar (*f*) at the right of the instrument. The piece may be actuated either by a small motor or by a gravity-gear. It is suitable for large or small lecture-room or for the laboratory.

MADISON BENTLEY.

Automatic Tuning-Fork Hammer

(Fig. 5)

As first designed, this instrument was intended to serve as a single unit in a series of eight forks for demonstrational use. It has, however, been found to be very useful also in experimental work. It combines the following features.

(1) The fork is struck rapidly and precisely by a single movement of the hand. It is thus possible to control with accuracy the time of striking. Two or more forks may be so struck together or in succession as to give an interval or a simple melody. A single fork may be repeatedly sounded at very short intervals,—an advantage not shared by those mechanical strikers in which the hammer has to be set by hand before it can be released for the blow.

The mechanism includes a hammer-piece (H) and a key-rod (R) separate, but pivoted about the same axis, the latter being forked about the former. The key-rod passes through a slot in the slide (S) which is free to move vertically in ways fastened to a vertical post. The slide carries a small roller, which works in a slot cut in the key-rod, so that, when the key-rod is depressed, the slide is also depressed. Below the roller the slide carries a pawl (P) which engages, when the slide is depressed, with the horizontal arm of the hammer-piece, until, upon being depressed further, the arm is released by clearing the pawl. Thus the hammer, a rubber cushion set in the end of a steel cylinder, is suddenly released, after being brought away from the fork against the action of the tension spring (T). After once striking the fork, the hammer is prevented from remaining in contact or from striking again by the flat steel spring (F). The slide and the key-rod are elevated after depression by the compression spring (C), the pawl being so pivoted as to slip by the arm of the

hammer-piece in the upward stroke. Both pawl and hammer-piece are made of tool steel; the other parts are of brass.

(2) The intensity may be accurately controlled. This is accomplished by a micrometer (M) to which the end of the tension spring is fastened. It is possible to get any intensity from zero up to a maximal strength. For the greater intensities, stronger springs can be used. In this way, the apparatus can be employed in work with the intensive limens.

(3) The fork is automatically damped by the felt damper (D) which is brought into contact with it when the key is released. As long as the key is depressed, however, the fork sounds. This arrangement is useful when different forks are to be struck in rapid succession without fusing, or when a melody is to be given. If desired, the damper can be readily removed, or can be made only partially effective by loosening the compression spring (C).

(4) The hammer can be quickly applied to almost any fork by fastening the wooden base on the resonance box, in which the fork fits, into the felt-covered clamp on the hammer-frame. The position of the hammer on its stem can be varied to the best striking position by means of a set-screw, and the distance of the hammer from the fork can be altered by loosening or tightening the tension spring (T).

(5) The device is supported upon two horizontal rods, which can be made of proper length to bear any number of units desired. It was in such a form that it was planned to build the eight units into a tuning-fork piano.

A single unit can be constructed of brass and steel with sufficient precision to insure accuracy in experimental work for about twenty-five dollars.

EDWIN G. BORING.

THE HISTORY AND STATUS OF PSYCHOLOGY IN THE UNITED STATES

By CHRISTIAN A. RUCKMICH, Cornell University

Since the birth of psychology in America, two attempts have been made to outline the period of its development and to take census at the particular stage of growth reached at the time. In 1891 W. O. Krohn[1] published an account of the work done at seventeen American colleges and universities, a description of the laboratories and the apparatus in use, a note on the development of the departments, and, in some cases, an evaluation of the equipment, including books, instruments, and scholarship and fellowship funds. A few sentences from his introductory paragraph illustrate the condition of psychology at that time. Speaking of the Leipzig laboratory, founded in 1879, he says:

> The value of their new experimental method so impressed these students that it was soon carried into effect in other institutions, and happily this new movement early found its way to America. To President G. Stanley Hall and Dr. J. McK. Cattell, Wundt's first American students, belongs the credit of introducing the experimental methods of treating psychology into the American college; the first laboratory being that of Johns Hopkins University at Baltimore, in which laboratory so many of the teachers of experimental and comparative psychology in the various colleges of the United States received their training. From this one comparatively small laboratory at Johns Hopkins the number has rapidly increased to fifteen now in actual use while no less than ten other institutions have taken steps to secure laboratory facilities within a year.

A few years after this account was written, E. B. Delabarre[2] published statistics with reference to the status of psychology in twenty-seven colleges and universities in America. In addition to historical data concerning the foundation of the laboratory, number of professors and students, and general laboratory equipment, he tabulated the evaluation

[1] W. O. Krohn: Facilities in Experimental Psychology in the colleges of the U. S., *Report of U. S. Commissioner of Education*, 1890-1891, 1139-1151.

[2] E. B. Delabarre: Les laboratoires de psychologie en Amérique, *L'Année psychologique*, I, 1894, 209-255.

of apparatus, amount of scholarship funds available, number and kind of courses offered, and type of research work pursued. Of the twenty-seven laboratories thus described, eight or nine were devoted exclusively to instruction and demonstration, five to eight were engaged in special research, and about ten were used for both instruction and research. In conclusion he says:

> Ce compte rendu correspond à l'état de la psychologie en Amérique vers la fin de 1894. Mais l'intérêt de notre pays pour les études psychologiques est si développé et si profond que le compte rendu de l'heure présente ne sera plus vrai demain. Le nombre des laboratoires continue à augmenter rapidement. . . . Les laboratoires existant augmentent rapidement leurs ressources, et quelques-uns qui n'ont encore qu'une importance secondaire peuvent d'un moment à l'autre recevoir de nouveaux crédits et passer au premier rang. Notre description s'applique par conséquent à un système qui est en voie d'évolution progressive, et qu'on doit juger surtout à ce point de vue.

The progress which Delabarre described in this article has continued almost steadily until the present time, when any large university in the country would consider its plant insufficient in equipment without a psychological laboratory of some sort. There is, however, to the best of the author's knowledge, no statistical inquiry of an adequate kind available, by means of which those interested in the matter can reckon up, as it were, the assets and liabilities in the account to date of our still youthful discipline. It would, in short, be a convenience to those who are watching the progress of the science, to have a brief, yet adequate, description of its attainments after over twenty-five years of growth.

In March, 1911, Titchener sent out a questionary for the purpose of obtaining material for an article on the historical development and present status of psychology in the larger colleges and universities of the country. Thirty-nine replies were received. When an attempt to systematise the results was made, it was soon discovered that in consideration of the promise of, and frequently because of the request for, privacy the significant facts concerning present conditions could not be published. These facts related, for the most part, to the status of psychology in regard to other departments; in particular, the relation of psychology to philosophy was subject to frequent criticism. It happened that at about the same time the writer was independently engaged in gathering material from the catalogues of a large number of academic institutions in the attempt to correlate the results for publication.

Opportunely, at the suggestion of Titchener,[3] we combined forces and material under a single heading. This work furnished the substance of a previous paper[4] which, enlarged and elaborated by means of a statistical inquiry conducted by the writer, gave rise, in turn, to the present article.

The questionary sought answers to the following:

(1) When was the psychological laboratory established?
(2) Who was placed in charge? With what academic title?
(3) Was the introductory course in psychology (general psychology, elementary psychology) assigned, at the above date, to the experimental psychologist? If not, what department had charge of it?
(4) Was this course independent, or was it offered in connection with (or in dependence upon) other specified courses?
(5) What, in these two respects, is the present status of the introductory course?
(6) With the establishment of the laboratory, was the department of psychology recognised as independent, or was it subordinated to some other department or division? In the latter event, what was its precise relation to the superior department?
(7) What, in this respect, is the present status of the department?
(The replies to the two remaining questions were regarded as confidential.)
(8) Are there any important events in the history of the department (dismissals, readjustments, etc.) that illustrate or supplement your replies to the preceding questions?
(9) What is your judgment of the present status of the department of psychology in your University?

The answers to these questions are condensed into the accompanying tabular arrangement. With that abbreviation goes some necessary injustice, because parenthetical qualifications and modifications are omitted in the last four columns. Official departmental relations are variously interpreted because of local considerations; where departments are technically separated and independent, the combination of courses in a group-system with those of other departments tends to bind the departments together in such manner that the link is often stronger than in cases of complete dependence. The writer was obliged, therefore, in a few instances, to make very 'close' decisions. On the whole, however, no great wrong was done. The essential facts of the table can be approximately summarised into the following:

Laboratories first began to appear in definite form late in the 'eighties.' Up to and including 1890, 8 such laboratories had been started, and 5 of these were at western state insti-

[3] For the material gathered from the questionary and for timely suggestions, I wish to express my indebtedness to Professor Titchener.

[4] Read before the meeting of the Association of Experimental Psychologists at Clark University, April 16, 1912.

TABLE I. SYNOPSIS OF STATISTICS FROM HISTORICAL QUESTIONARY

	Institution	(1) Lab. Estab'd?	(2) In Charge?	Title?	(3) In Charge Intro. Psych?	(4) Ind't Then?	(5) Ind't Now?	(6) Dept. Ind't Then?	(7) Dept. Ind't Now?
1	Harvard	74–6	James	I anat & physio	James	*Yes*	*Yes*	No—ph	No—ph
2	J. Hopkins	83–4	*Hall*	P p & ped	*Hall*	No—ph	No—ph	*Yes*	*Yes*—ph & ed
3	Indiana	88	Bryan	H ph	Bryan	No—ph	*Yes*	No—ph	No—ph
4	Wisconsin	88	*Jastrow*	P exp & comp p	*Jastrow*	*Yes*	*Yes*..ed	No—ph	No—ph
5	Clark Univ.	89	*Sanford*	I p	*Sanford*	*Yes*	*Yes*	*Yes*	*Yes*
6	Nebraska	90	Wolfe	P ph	Wolfe	*Yes*	*Yes*	No—ph	No—ph
7	Michigan	90	Tufts	I ph	Dewey	No—ph	*Yes*	No—ph	No—ph
8	Iowa	90	Patrick	I ph	Patrick	No—physio	*Yes*	*Yes*—ph	*Yes*—ph
9	Columbia	90–1	*Cattell*	P exp p	ph	No—ph	*Yes*	*Yes*	*Yes*
10	Cornell	91	*F. Angell*	AP p	ph	No—physio & ph	*Yes*	No—ph	*Yes*—ph
11	Wellesley	91	*Calkins*	I p	*Calkins*	*Yes*	*Yes*	No—ph	*Yes*—ph
12	Brown	92	*Delabarre*	AP p	*Delabarre*	*Yes*	*Yes*	No—ph	No—ph
13	Illinois	92	*Krohn*	P p	*Krohn*	*Yes*	*Yes*	*Yes*	*Yes*
14	Kansas	92	Templin	AP ph	Templin	*Yes*	*Yes*	No—ph	No—ph
15	Chicago	93	*Strong*	AP p	*Strong*	*Yes*	*Yes*	No—ph	*Yes*
16	Princeton	93	*Baldwin*	P exp p	ph	No—ph	No—ph	No—ph	No—ph
17	Yale	93	*Scripture*	I exp p	ph	No—ph	No—ph	No—ph	No—ph
18	Minnesota	93–4	J. Angell	I ph	ph	No—physio	*Yes*	No—ph	No—ph
19	Wesleyan	04	*Shaw*	As p	ph	No—ph	No—ph	No—ph	No—ph
20	Smith	95	Smith		p & ph	No—ph	No—ph	No—ph	No—ph
21	California	96	*Stratton*	I p	*Stratton*	*Yes*	*Yes*	No—ph	*Yes*—ph
22	Ohio State	97	Wissler	As ph & ped	ph	No—ph	*Yes*	No—ph & ed	*Yes*
23	Bryn Mawr	98	*Leuba*	AP p & ed	*Leuba*	No—ph	No—ph	*Yes*—ph	*Yes*
24	Texas	98		I ph	ph	*Yes*	*Yes*	No—ph	No—ph
25	Missouri	00	*Meyer*	P exp p	*Meyer*	*Yes*	*Yes*	*Yes*	*Yes*
26	Northwestern	00	*Scott*	I p & ped	*Scott*	*Yes*	*Yes*	No—ph	*Yes*
27	Wyoming	00	Downey	I eng	Downey	*Yes*	*Yes*..ed	No—ph	No—ph
28	Washington	01	Colgrove	P ph	Colgrove	*Yes*	*Yes*	No—ph	No—ph
29	Colorado	01	Libby	H ph	*Allin*	*Yes*	*Yes*..ed	*Yes*	*Yes*
30	Cincinnati	01	*Judd*	P p	*Judd*	*Yes*	*Yes*	*Yes*	*Yes*
31	Mt. Holyoke	02	Thompson	I ph	ph	*Yes*	*Yes*	No—ph	*Yes*—ph
32	Tennessee	02	*Breese*	P p & eth	*Breese*	Yes....ed	*Yes*	*Yes*	*Yes*
33	Vassar	03–4	Washburn	AP ph	Washburn	*Yes*	*Yes*	No—ph	No—ph
34	Bowdoin	04	*Burnett*	I p	*Burnett*	*Yes*	*Yes*	No—ph	*Yes*
35	Montana	09	*Book*	P p	*Book*	*Yes*	*Yes*	No—ph	*Yes*—ph
36	Tufts	10	*Scott*	P p & ed	*Scott*	*Yes*	*Yes*	*Yes*—ed	*Yes*—ed
37	Dartmouth	11	*Bingham*	AP p & ed	*Bingham*	*Yes*	*Yes*	*Yes*—ph	*Yes*—ph
38	Vermont	—	—	—	Gifford	No—ph & ed	No—ph & ed	No—ph	No—ph & ed
39	Amherst	—	—	—	—	No—ph	No—ph	No—ph	No—ph

SYMBOLS USED

AP	Assistant or Associate Professor	exp	Experimental	ph	Philosophy	*italics*	emphasise recognition of psychology as an independent discipline. Italicised names indicate official rank as psychologists.
As	Assistant	I	Instructor	ped	Pedagogy		
anat	Anatomy	ind't	Independent	physio	Physiology		
comp	Comparative	intro	Introductory	— (after 'no')	under		
ed	Education	H	Head of Department	— (after 'yes')	co-ordinate with		
eng	English	P	Professor	.....	tendency toward alliance with		
eth	Ethics	p	Psychology				

tutions. For three years thereafter three laboratories were founded per year. Then the pace kept on by ones and twos, with threes in 1900 and 1901, until a halt was called in 1904. A few more have come since then. The two most prolific periods seem to be about 1890 and 1893. It is interesting to note that with the appointment of Scripture at Yale in 1893 used as a node to divide the series, the percentage of total appointments assigned to men with academic rank in psychology (as indicated by italics) is approximately the same for each period, although the division favors the first period on account of its temporal brevity. Altogether 22 out of 36 (61 *per cent.*) held such title at the time of appointment. More recently, also, the introductory courses have gone to psychologists and have received greater independent recognition, especially since 1898. This result is not wholly unexpected, because seven of the courses in introductory psychology, though not originally independent, have now become self-sustaining. Eight courses, however, are still, in one way or another, dependent on some other department, usually on that of philosophy. Eight departments of psychology have been created out of former alliances with philosophy, but eighteen institutions still have affiliations of psychology to philosophy.

Reading horizontally across the table, we find the following conditions to hold: 7 out of the 39 institutions, viz., Clark, Illinois, Missouri, Cincinnati, Tennessee, Tufts, and Dartmouth, have had psychologists in charge and have had their department and courses independent from the beginning of things; 9 more, viz., Harvard, Wisconsin, Nebraska, Brown, Kansas, Texas, Wyoming, Washington, and Vassar, have always had their introductory courses independent, but have departmental affiliations to some other discipline, usually philosophy; to this list 7 institutions, viz., Wellesley, Chicago, California, Northwestern, Mt. Holyoke, Bowdoin, and Montana, may be added as institutions which hold to these conditions (*i. e.*, introductory courses were always independent, and departments have been dependent) with the exception that their departments are now independent; 2 institutions, viz., Iowa and Columbia, have had their introductory courses dependent, but now have those courses, and always have had their departments, independent; 2 more, viz., Cornell and Ohio State, have had both department and introductory courses dependent, but have relieved themselves of that condition now. Many more comparisons could be drawn.

Statements made in answer to the last two questions were promised confidential treatment, and will therefore be pre-

sented without reference to source. Local identification and definite orientation would, indeed, contribute to the adequate interpretation and significance of the remarks made, but the limitation imposed is, of course, a necessary one. For that reason, pertinent generalisations must be our only resource.

The replies seem to group themselves roughly into two large categories: (1) those coming from departments of psychology that are independent, and (2) those coming from departments affiliated to other departments, or combined with another discipline into a single larger department. The second group subdivides into three sections: (*a*) conditions are reported as favorable and satisfactory, (*b*) conditions are reported as unfavorable, owing to demands made upon psychology by education, and (*c*) conditions are reported as unfavorable because of affiliations to philosophy.

In the institutions where psychology is absolutely independent, there seems to be, in general, no cause for complaint. Full recognition has not only been gained, but also, in almost all cases, rapid progress is being made in the way of increasing registration of students, academic work accomplished, and the establishment of prestige in the institution. If a general impression is allowed, it would not be far amiss to state that the replies from such departments are enthusiastic and hopeful. In one or two instances, especially from state-controlled institutions of the west, a note of regret was heard in regard to the demands that the department of education, usually a state board, was making at the hands of the psychologist. In such cases, a direct attack, in contrast to insidious attacks made elsewhere when numerous applied problems are brought to the theoretical psychologist for solution, is hardly unexpected, and gives a good example of the practical tendencies of many of our state universities. The pressure, however, is not very frequent or very heavy, and can be met in time by the appointment of an educational psychologist whose point of view is that of application. Wherever psychology is affiliated to other departments, in most cases to philosophy, more infrequently to education, we have a twofold possibility of conditions: either (1) the situation is agreeable and satisfactory, or (2) complaint is made. In about one half of the institutions where psychology is affiliated to philosophy, conditions are reported as favorable to the younger discipline. It must be noted that there are many degrees of affiliation, and that most of the favorable reports come from institutions where the affiliation is partial and for the most part theoretical. In some universities, the philosopher was on the ground first,

and is technically the head of the combined department of philosophy and psychology, but he receives a salary equal to that of the psychologist, sometimes has less 'academic prominence,' and frequently allows the psychologist to go to the president, or board of trustees, directly, for administrative consultation. In such instances there seems to be good personal relationship and friendship in the combined department. In the remaining situations, where this favorable condition does not exist, the reasons for complaint are various. The most frequent complaint is to the effect that wherever students in psychology are also required to elect philosophy they fall into a 'philosophising tendency' which works havoc with the empirical approach attempted by modern psychology. Here seems to lie the main point at issue. In spite of repeated efforts to the contrary,[5] it must be conceded by the philosophers that the method of approach of their discipline and sub-disciplines is not of the same empirical nature as is that of the psychological laboratory. Furthermore, in most instances of satisfactory condition between psychology and philosophy, it is found that the type of psychology taught, as outlined in the catalogues of the institutions concerned, is the philosophical, non-empirical, generalising variety current before 1880. It is not the purpose of this paper to discuss at length the question of the nature of experimental psychology as compared with that of the philosophical disciplines, but to record the opinions of those who answered the questionary. A number of these replies indicate, in no uncertain terms, that affiliation to philosophy is unfortunate;[6] that, if affiliation becomes necessary on the score of administrative economy, occupancy of the same building, and elective group systems, in at least three instances, academic relationship with the biological sciences is preferred; and that the 'scientific approach' of experimental psychology is responsible for the steady progress of the discipline. There are other handicaps imposed upon psychology in institutions where the science is not independent. Sometimes philosophical courses are made compulsory, while psychological courses are entirely elective; often psychological courses can be elected only in conjunction with philosophical courses; frequently an old-fashioned pedagogical department demands a primitive type of educational

[5] For a detailed discussion of the subject see E. Albee: Descriptive and Normative Sciences, *Philosophical Review*, xvi, 1907, 40; J. Boodin: *Truth and Reality*, 1911, 288; G. Sabine: Descriptive and Normative Sciences, *Philosophical Review*, xxi, 1912, 433.

[6] As early as 1891, H. Münsterberg advised a separation of psychology and philosophy: *Aufgabe und Methoden der Psychologie*, 1891, 270.

psychology. In two institutions the department of psychology seems to be doomed to elimination for financial and personal reasons. In general, however, the progress of psychology is assured. In several institutions an independent department of psychology is about to be, or has been at this time, about a year after the expectation was expressed, established. The total impression gotten from a perusal of the comments contained in the replies is one of patient endurance not uncolored with the hope for better things to come.

The second part of the investigation was made with a view to compare, if possible, the standing of psychology as an academic discipline with that of several other disciplines. In the search for a discipline of approximately the same age as psychology, we discovered that political economy, established as an academic discipline about 1885, at the time of the meeting of the American Economic Association, would meet the requirements. Education and physiology were next suggested, because of their intimate historical connection with psychology, contributing, respectively, educational and physiological psychology. Physics was next considered because of its well-established recognition as an empirical science, and because of its traditional relations with the mental sciences in the field of knowledge,[7] and then philosophy because it, without doubt, is the parent of psychology in this country. As the work of gathering material from the 1910-11 catalogues of the 39 institutions was proceeding, it became evident that physiology did not lend itself to treatment, because its academic demarcation from such subjects as anatomy, medicine, morphology, histology, and biology was far from rigid. Complications also arose in connection with the medical schools of universities. Zoölogy was therefore substituted for physiology. The material gathered consisted of the number of professors, assistant or associate professors, instructors, and assistants, together with the number of subject hours per week per year for each of the six disciplines named, in each of the 39 institutions. Whenever an officer is connected with more than one department, an equal portion of his time, and, consequently, also his statistical value, is assigned to each department; *e. g.*, a professor of philosophy and psychology obtains one-half credit under philosophy and one-half under psychology. The distribution of officers among the disciplines is, then, as follows: physics, 265 (66 professors, 62

[7] This may be expressed by the Cartesian formula: *World = Mind + Matter*, or by the Herbartian equation: *World of knowledge = Mental Sciences + Natural Sciences.*

assistant professors, 64 instructors, 73 assistants); zoölogy, 175.5 (51 professors, 45.5 assistant professors, 39 instructors, 40 assistants); political economy, 175 (62.5 professors, 46 assistant professors, 41 instructors, 25.5 assistants); philosophy, 123.5 (73 professors, 20.5 assistant professors, 15 instructors, 15 assistants); education, 102 (50 professors, 27.5 assistant professors, 13.5 instructors, 11 assistants); and psychology, 88.5 (32.5 professors, 19 assistant professors, 19 instructors, 18 assistants). The total number of academic hours ('university hours' per year) offered by each discipline is: political economy 3009, physics 2740, zoölogy 1944, philosophy 1671, education 1392, psychology 1190.

It was then considered desirable to correlate the number of university officers with the number of hours offered in each of the six disciplines in every one of the 39 institutions. In order to do this, and in the absence of any other recognised method of procedure, the academic rank of instruction was weighted by a factor proportionate to the relative average salary for that rank in America.[8] These factors were 2.5 for professorships, 1.75 for assistant professorships, 1. for instructorships, and .5 for assistantships; *i. e.*, the total number of hours offered at a given institution in a given subject was multiplied by 2.5 for every professor in that subject, by 1.75 for every assistant professor, and so on. The product, because the instructor factor is unity, is termed the 'instructor hour.' Academic titles of officers determine the tabulation under the department: the fact that, *e. g.*, an instructor in psychology gives courses in education does not classify him under 'education,' but the fact that he has academic rank and title 'in psychology' gives him the qualification of classification under 'psychology.' Associate professors, or associates, or preceptors (at Princeton) are classified under 'assistant professor.' Hour units are for one academic year exclusive of summer sessions, and courses in the summer session are not counted. Additional sections in a single course are counted as additional semesters with the corresponding number of hours. Educational psychology is credited under psychology. When courses in education are given in a separate school of education, only those courses are counted which bear on the theory, philosophy, and principles of education. Practical and technical courses are

[8] The Carnegie Foundation for the Advancement of Teaching: *The Financial Status of the Professor in America and in Germany*, Bulletin 2, May, 1908, 21, 30, 31, is responsible for the following average salaries: professor $2500, associate professor $1900, assistant professor $1600 (average of the two $1750), instructor $1000, and assistant $500.

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TABLE II. RELATIVE RANK IN TERMS OF 'INSTRUCTOR-HOURS'

	Psychology	Education	Zoölogy	Pol. Econ.	Physics	Philosophy
Columbia†	1730	1370	1655	1060	4180	3561
Chicago	420	885	756	1127	924	500
Minnesota	131	525	1180	602	602	134
Cornell†	232	157	214	1650	4560	1020
Wisconsin†	150	530	572	3220	2140	475
Michigan	105	376	701	859	2640	728
Illinois†	258	502	1230	1658	1463	205
Northwestern	119	140	310	427	162	119
Nebraska†	28	510	860	615	1065	585
Harvard†	279	270	920	1425	1362	1362
California†	158	501	731	420	1230	644
Ohio State	280	392	1104	926	1662	420
Yale	375	48	1120	1542	2920	1090
Missouri	442	98	252	374	493	185
Texas	20	1200	292	212	605	170
Kansas†	132	803	899	220	693	246
Indiana	117	608	378	351	434	188
Washington†	59	497	542	875	426	138
Iowa	130	545	1118	1035	882	155
Tennessee	20	57	54	15	20	22
Princeton	72	—	30	667	1733	568
Smith†	108	69	210	72	256	217
Cincinnati†	81	98	120	42	575	63
Colorado	94	262	75	83	184	93
Dartmouth†	37	9	114	360	287	45
Wellesley†	167	45	314	280	203	127
Tufts	6	3	190	126	115	210
Vassar†	48	3	45	112	298	90
Brown	80	132	96	213	360	384
J. Hopkins	111	5	298	136	781	159
Mt. Holyoke†	96	45	150	21	290	77
Vermont†	8	60	46	166	98	25
Amherst†	13	6	60	102	126	32
Bryn Mawr	90	12	81	136	170	273
Bowdoin†	45	—	58	26	40	30
Wesleyan†	38	—	35	27	253	50
Wyoming	26	75	22	101	150	20
Montana	41	37	61	24	75	17
Clark Univ.	126	25	50	14	120	8

† Marks institutions represented in the last three tables.

excluded. Political economy or economics is differentiated from political science and sociology. The latter courses are excluded. The results of this correlation appear in Table II. In this and the following tables, institutions are placed in the

order[9] of total registration of students in the institution, highest registration leading. Of the 39 institutions tabulated, 19 appear in the two following tables (indicated by obelisk). Since a cross comparison will later be made between the three tables, it was deemed necessary to calculate averages for only these 19 institutions. The average number of 'instructor hours,' therefore, is: physics 1029, political economy 650, philosophy 473, zoölogy 451, education 288, and psychology 193. Expressed in *per cent.*, the disciplines rank, according to this comparison: physics .334, political economy .211, philosophy .152, zoölogy .146, education .094, and psychology .063.

By means of correspondence it was possible to procure the number of student registrations for each of the disciplines in a large number of these 39 institutions. It was not possible to establish a uniform method of counting these registrations, because some of the figures given represent registrations, others eliminate double or triple registrations, *i. e.*, cases where the same students are registered in more than one course at a time, and thus represent separate students. No great error, however, results. Most of the figures given are actual registrations and not estimates. Registrations for both semesters are added, giving registration for the year, 1910-11. To obtain averages for the six disciplines compared in the 19 institutions, it was necessary, in a few instances, to divide the registration given for combined departments, arbitrarily, into equal shares under the heading of the disciplines that were thus combined. The average registrations thus derived are: political economy 636, physics 568, philosophy 298, education 292, psychology 244, zoölogy 187. Arranged in *per cent.* of distribution, these figures give: political economy .286, physics .255, philosophy .133, education .132, psychology .110, and zoölogy .084.

One of the most adequate bases of statistical comparison seems to be the financial; but it is at once the most difficult of treatment. Although treasurers' accounts are not as unintelligible and as unsystematic as they are sometimes said to be,[10] enough deviation from a standard method exists to make occasional trouble. Luckily most of these deviations did not materially affect this investigation. Most of the confusion arose because of the way in which expenditures for several

[9] *The World Almanac*, 1912, is authority for this order. No more reliable source of information was at hand which gave statistics for all the institutions considered. The order is based on registration figures for 1910-11, including summer session.

[10] C. F. Birdseye, *The Reorganisation of our Colleges*, 1909, 340.

TABLE III. REGISTRATION

	I Psychology	II Education	III Zoölogy	IV Pol. Econ.	V Physics	VI Philosophy
Columbia†	210	1725	102	*ES* 445	830	466
Minnesota	736	626	1047	1286	399	259
Cornell†	318	243	118	*EL* 2214	4200	543
Wisconsin†	347	365	68	1290	553	168
Illinois†	412	280	382	418	1050	304
Nebraska†	*312	320	173	303	248	I
Harvard†	303	299	244	2332	330	828
California†	VI	836	521	485	1205	*1461
Kansas†	376	160	257	533	126	378
Washington†	VI	216	178	439	280	*248
Smith†	VI	VI	195	337	160	*597
Cincinnati†	164	471	111	354	238	210
Dartmouth†	54	14	121	918	763	76
Wellesley†	303	134	189	441	123	259
Tufts	43	9	1	55	78	84
Vassar†	382	32	36	567	219	542
Mt. Holyoke †	190	190	334	122	162	85
Vermont†	21	40	30	20	42	20
Amherst†	164	18	330	260	122	270
Bryn Mawr	*135	16	*BEm* 79	122	61	I
Bowdoin†	95	—	124	350	59	129
Wesleyan†	97	—	49	257	81	182

BEm Biology and embryology combined with zoölogy.
EL Economics and sociology combined with political economy.
ES Economics and political science combined with political economy.
* Indicates that number so marked is shared by some other department.
Roman numerals indicate the department with which the registration is shared.
† Marks institutions represented in the last three tables.

departments or disciplines were lumped into a single budget. Difficulty also arose from the fact that in some cases there were special reasons for an abnormal—either subnormal or supernormal—expenditure, such as reduced salaries paid to substitutes during a regular officer's leave of absence, increased appropriation because of a method of annual rotation of appropriation among the departments, decreased appropriation because of a previous year's unusually large expenditure, or because of a special reorganisation of a department. The amounts given under 'other appropriations' are not uniformly classifiable under any definite heading. As a rule, however, administrative and building expenses are excluded. We have, then, presented in Table IV a list of expenditures

TABLE IV. APPRO

	I. Psychology			II.	Education		III. Zoology		
	A.	B.	C.	A.	B.	C.	A.	B.	C.
Columbia†	$12350	$1199.43	$13549.43	$156750	—	$156750	$32450	$4768.36	$3721
Chicago	10164	1553	11717	29866	$650	30516	15545	3594	1913
Cornell†	7750	1340.49	9090.49	6000	865.44	6865.44	—	—	—
Wisconsin†	VI	VI	VI	12100	500	12600	7800	500	830
Michigan	4050	600	4650	9800	100	9900	11600	1585	1318
Illinois†	6400	1650	8050	7200	1750	8950	16850	2100	1895
Northwestern	3550	200	3750	1700	—	1700	6800	750	755
Nebraska†	3715	210	3925	8900	150	9050	6150	1265	741
Harvard†	VI	150	VI 150	10250	100	10350	23150	450	2360
California†	VI	VI	VI	15500	600	16100	25350	2350	2770
Ohio State	4300	4.28	4304.28	7550	100	7650	8700	1250	995
Missouri	4100	1075	5175	18000	2800	20800	7100	4578	1167
Texas	II	II	II	*12250	*650	*12900	6800	1800	860
Kansas†	VI	VI	VI	9470	1165	10635	8525	1175	970
Indiana	*6200	*639.89	*6839.89	7900	851.21	8751.21	4200	1333.54	553
Washington†	3150	350	3500	8675	300	8975	5700	1000	670
Iowa	VI	VI	VI	10120	400	10520	12600	550	1315
Tennessee	*2000	200	*2200	2000	—	2000	2000	2000	400
Smith†	3000	150	3150	1500	25	1525	6400	2050	845
Cincinnati†	3275	7.20	3282.20	—	—	—	*B* 7391	2914.58	1030
Colorado	2050	200	2250	4450	500	4950	*B* 5000	800	580
Dartmouth†	II	216	II 216	*2000	—	*2000	*B* 9787	2190	1197
Wellesley†	*7250	*200	*7450	2450	—	2450	8900	500	940
Vassar†	3950	89	4039	VI	VI	VI	*B* 7150	928	807
Mt. Holyoke†	*4650	*117.69	*4767.69	1800	—	1800	5700	726.52	642
Vermont†	VI II	VI II	VI II	*2500	—	*2500	1450	199.55	164
Amherst†	VI	VI	VI	500	—	500	6300	1482.26	778
Bowdoin†	2500	150	2650	1000	150	1150	2400	400	280
Wesleyan†	II	II	II	*2500	*567.16	*3067.16	*B* 3900	399.83	429
Montana	II	II	II	*3450	*400	*3850	2600	680	328

A. Indicates appropriations for salaries of academic officers.
B. Indicates appropriations for other purposes,—books, apparatus, etc.
C. Indicates total appropriations.
* Indicates that amount so marked is shared by some other department.
Roman numerals indicate the department with which the appropriation is shared, *e.g.*, I, psychology; II, education, et
† Marks institutions represented in the last three tables.

PROPRIATIONS

	IV. Political Economy			V. Physics			VI. Philosophy		
C.	A.	B.	C.	A.	B.	C.	A.	B.	C.
$37218.36	*E* $19400	$900	$20300	$18200	$7037.14	$25237.14	$31200	$34.79	$31234.79
19139	21620	850	22470	22738	5587	28325	12739	485	13224
—	*EL* 19025	666.02	19691.02	42316	5400.77	47716.77	14050	347.53	14397.53
8300	31520	350	31870	26350	1000	27350	*12650	*500	*13150
13185	19300	245	19545	19300	2925	22225	10000	—	10000
18950	22200	2800	25000	22620	7595	30215	6000	150	6150
7550	6200	100	6300	6100	3000	9100	3500	—	3500
7415	*SEL* 14625	125	14750	12765	2520	15285	4200	50	4250
23600	31750	1550	33300	26900	1000	27900	*35750	—	*35750
27700	*E* 20440	1440	21880	25339	8446	33776	*15950	*1160	*17110
9950	3850	—	3850	15200	2920	18120	4300	53	4353
11678	6800	350	7150	7220	3890	11110	4200	150	4350
8600	5500	200	5700	5650	2300	7950	3800	400	4200
9700	*HE* 11250	750	12000	6550	2300	8850	*8480	*775	*9255
5533.54	*EL* 5700	553.45	6253.45	5350	1614.16	6964.16	I	I	I
6700	9450	750	10200	6375	2350	8725	2550	350	2900
13150	9650	250	9900	8400	1000	9400	*8750	*300	*9050
4000	*HE* 1800	—	1800	1800	200	2000	I	I	I
8450	4400	325	4725	5300	500	5800	5900	200	6100
10305.58	*S* 3125	—	3125	8922	1841.63	10763.63	2700	—	2700
5800	*EL* 3200	200	3400	3700	1000	4700	2800	150	2950
11977	7650	—	7650	7950	1375	9325	2500	—	2500
9400	3850	—	3850	*A* *9100	*700	*9800	I	I	I
8078	5400	—	5400	7950	635	8585	*3900	—	*3900
6426.52	3925	50	3975	4850	893.36	5743.36	I	I	I
1649.55	3800	—	3800	2800	369.55	3169.55	*2000	—	*2000
7782.26	5000	68.31	5068.31	6200	553.86	6753.86	*4600	*216.79	*4816.79
2800	1850	100	1950	2500	400	2900	1500	50	1550
4299.83	2500	—	2500	6550	911.48	7461.48	3000	—	3000
3280	2200	400	2600	1600	470	2070	II	II	II

A Astronomy combined with physics.
B Biology.
E Economics.
Em Embryology.
H History.
L Sociology.
S Political Science.

n, etc.

for the six disciplines in a number of institutions for the academic year 1910-11.[11] Whenever an expenditure covers more than the discipline in whose column it is found, that fact is recorded either by a symbolic letter prefixed to the amount, which letter is interpreted in the legend, or by an asterisk, in which case the department which shares the amount is indicated by a Roman numeral referring back to the column where the amount is found. In the comparison of appropriations given below,[12] an arbitrary division similar to that made in Table III has been resorted to in cases where a number of departments share a given amount. It is assumed, for purposes of correlation, that the amount is equally shared. All of the deviations described are so comparatively few in number, and generally affect the 19 institutions compared to so small an extent, that they may be virtually neglected. The average appropriations for the six disciplines in the 19 institutions considered are, then, as follows: physics $15545, education $13350, political economy $12160, zoölogy $11090, philosophy $6545, and psychology $5285. Converted into *per cent.* of money distribution, these amounts give the following results: physics .240, education .210, political economy .191, zoölogy .175, philosophy .102, and psychology .082. Combining Tables III and IV, we get the following *per capita* expenditure: zoölogy $59.32, education $45.73, physics $27.58, philosophy $21.97, psychology $21.67, and political economy $19.12.

An attempt was made to summarise the results of these three tables by means of a correlated average rank for each of the six disciplines. The application of Spearman's 'foot-rule' indicated, however, that the correlation was neither constant nor adequately representative. The best we can do, then, is briefly to outline the facts brought out in the tables. On the whole, psychology foots the lists more often than any other discipline. In this respect it is the most consistent of them all. Political economy, of equal age with psychology, heads the list with the greatest number of university hours, while psychology foots the list with the lowest; in the matter of appropriations, education, the youngest of all the disciplines

[11] The single exception is the University of Cincinnati whose fiscal year ends Dec. 31. The year given in this case ends Dec. 31, 1911.

[12] Grateful acknowledgment must be made of the courtesy shown by correspondents in furnishing the desired information. All of the material used in this article was obtained by the author through replies made to questionaries. Realising the usual annoyance arising from this form of request, the author wishes to give full recognition to the kindness shown by these correspondents.

represented, and political economy, occupy second and third places respectively, while psychology occupies the last; in the number of 'instructor hours,' political economy is second in rank, psychology is lowest; in the number of officers of instruction, political economy is third on the list, psychology is last; in the matter of student registration, political economy heads the list, psychology occupies the next to the last place; education leads with the largest *per capita* expenditure, psychology is next to the end.

After this statistical presentation, a few remarks concerning the condition of psychology as an academic discipline may not be out of place. We find that psychology, after over 25 years of growth, does not stand very high on the honor roll among other academic subjects. Other disciplines, of equal age or younger, have, in several instances, decidedly surpassed it in rank. Various explanations may suggest themselves, but the following seem to the writer to be the most adequate:

(1) Ranking in terms of financial support given, number of student registrations, and the like, may not sufficiently interpret academic prestige, or account for the work that a discipline has accomplished among other disciplines. Certainly education has emphatically, physiology and the social sciences have to some extent, benefited by the application of results obtained in the psychological laboratory. How much, on the other hand, psychology is indebted to physics for its contributions to psychophysical problems, to physiology and anatomy for their functional and structural points of view and facts, to anthropology and the social sciences for their contributions to genetic and group psychology, and to zoölogy for suggestions in comparative work, is, likewise, a difficult matter to compute.

(2) Pure sciences, without definite aim at application, are usually slow of academic growth at the beginning of their establishment. The smaller the possibility of application, the slower is the growth: witness such sciences as astronomy, botany, zoölogy, and geology,—astronomy probably footing the list, if a general impression be allowed, with a correspondingly small possibility of application.

(3) The hardships of progress are most decidedly emphasised when the discipline in question is attempting to gain credit at once in the world at large and in the university, *i. e.*, when it lacks a long historical development antedating

academic recognition. If its progress is well established before the university appears on the scene, attainment of academic approval is easy and rapid. Experimental psychology originated in 1879, and during the next few years it was already a candidate for admission to the American academic curriculum. Its academic growth is, therefore, almost coëval with its progress in the world at large.

(4) The establishment of laboratories in connection with an empirical psychology is necessarily slow and laborious because of the initial expense involved, and for the reason that space has to be procured and a staff of assistants must be chosen. This may explain, in a measure, the fact that the *per capita* expenditure for psychology, a laboratory science, is about equal to that of philosophy, not a laboratory science. Adequate laboratories have not been everywhere provided.

(5) The introspective method, peculiar to the psychologist, may offer a hindrance to the ready acceptance of the discipline because of the false assumption that it requires either an abnormal gift of some sort or years of toilsome training. The very fact that the method is itself variously interpreted, and sometimes poorly understood even by psychologists, suggests that there is difficulty.

Some of these explanations may be found to apply to other disciplines as well; but, perhaps, psychology suffers to the greatest degree because in her case all of the factors mentioned operate together.

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THE EFFECT OF ILLUMINATION ON PERIPHERAL VISION [1]

By Lucy May Day

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[1] From the Psychological Laboratory of Cornell University.

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Introduction

I. Problem.—In a cluster of recent studies[1] in peripheral vision, we find the statement that peripheral stimuli, which are themselves subliminal as regards color, may under favorable conditions induce colored after-images. These anomalous after-images are said to appear most often under conditions of intense illumination, with the stimuli shown upon a white background. On account of the theoretical importance of this statement, it was thought worth while to repeat the experiments. With this end in view, certain experiments were performed in the Cornell Laboratory by Titchener and Pyle.[2]

[1] H. B. Thompson and K. Gordon: A Study of After-Images on the Peripheral Retina, *Psychol. Rev.*, XIV, 1907, 122-167. G. M. Fernald, The Effect of the Brightness of Background on Color in Peripheral Vision, *Psychol. Rev.*, XII, 1905, 386-425; *ibid.*, XIV, 1908, 25-43; also *Psychol. Monographs*, X, no. 3, 1909.

[2] E. B. Titchener and W. H. Pyle, On the After-Images of Subliminally Colored Stim., *Proc. Amer. Philos. Soc.*, XLVII, No. 189, 1908, p. 377.

The outcome was negative. It seemed, however, that the "most favorable conditions" required had not been secured; and further tests were therefore necessary.

The present study was undertaken largely for the purpose of furnishing such supplementary tests. It was thought, moreover, that further work might throw light on certain irregularities in Fernald's general results. We undertook, therefore, to repeat Fernald's experiments, with additional variations, under exactly duplicate conditions.

After our experiments had been completed and put in what then seemed final form, a paper appeared[3] in which Fernald's theses were attacked from a new direction. Rand and Ferree now declared that instead of selecting the most favorable conditions for her phenomena—colored after-images from colored stimuli sensed as colorless—Fernald had chosen the very worst. They were unable to confirm the results that she obtained in the Bryn Mawr and Chicago laboratories; *i. e.*, they failed (as a rule) to get the anomalous colored after-images, when a white background was used. On the other hand, they were able, if they used a black background, prefixation ground, and projection ground, to secure these anomalous after-images practically in every trial.

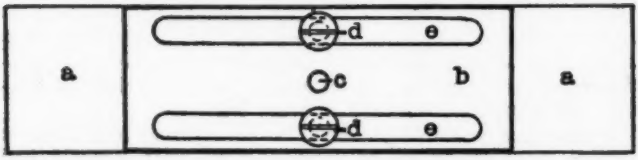
These new results—obtained in both direct and indirect vision—were startlingly at variance with what Fernald had found in her work with the black background; they were, moreover, the reverse of what our experiments had yielded. Indeed, they so flatly contradicted our findings that it seemed prudent to put them again to the test before advancing our own observations. It was evident that the method of Ferree and Rand differed in some details from ours—exactly in what ways, we could not fully make out from the (thus far) incomplete account of their method. We were told, however, that for the best results a black background, prefixation ground, and projection ground should be used; and that the white after-image of the black prefixation ground (fixated for 5 or 10 sec.) should be projected on the stimulus, which should itself be fixated for only 2-3 seconds. With these meagre directions to guide us, we repeated a large part of the work with the black background. The variations in method introduced, and the results obtained, will be given under the proper headings in the body of this paper.

[3] C. E. Ferree and G. Rand, Colored After-Images and Contrast Sensations from Stimuli in which no Color is Sensed, *Psychol. Rev.*, XIX, 1912, 195-239.

II. Apparatus.—The apparatus employed was, so far as seemed advisable, identical with that of Fernald. It consisted of a vertical two-sided campimeter similar to that pictured and described by her.[4] The stimulus frame was essentially the same as hers; but the screen which covered the stimuli, instead of being drawn to one side, was raised and lowered by a device which perhaps permitted greater rapidity of movement. When needed, an electric motor was suspended in the same position as the stimulus frame. The backgrounds used were platinum medium grey, white and black, and Hering velvet black. The stimuli were ten Hering colors: red, orange, orange-yellow, yellow, yellow-green, green, blue-green, blue, violet and purple; also Hering velvet black, and platinum grey.

Instead of a simple biting-board with triangular support, the Hering head-rest (with individual biting-boards) was used to

DIAGRAM OF ROTATION DEVICE ON BASE OF HERING HEAD-REST



a = depression in lower surface of base of head-rest.

b = movable brass plate, carrying pivot pin, *c*.

d, *d* = set screws in slots, *e*, *e*, for holding *b* in position.

keep the head in position. A special rotation-device[5] was arranged on the lower surface of the base, directly under *O*'s right eye (see diagram). The pivot pin *c* fitted into a hole in the table, which was in the plane of a perpendicular from the opening in the campimeter screen. For a given *O*, the plate *b* was so set that the distance from *c* to the center of the head-rest was exactly one-half the distance between the centers of *O*'s pupils. The modified head-rest thus provided for accurate determination of the position of *O*'s right eye (we used, as did Fernald, only the right eye, and stimulated only the left horizontal meridian of the retina), and in addi-

[4] *Psychol. Monog.*, X, No. 3, 1909, 16, 17. Details which were not clear to the writer were kindly furnished by Miss Fernald in correspondence.

[5] For this device we are indebted to Mr. W. S. Foster, assistant in the Graduate Laboratory.

tion for easy rotation to any desired angle. The adjustment once made was, therefore, constant for a given period of experimentation, and could easily be reproduced at subsequent sittings. It provided a further advantage, lacking in Fernald's arrangement, in that, after a single adjustment, *O* could fixate any number of points without turning his eyes.

The apparatus was set up in a large room (with light grey calcimined walls) on the top floor of the laboratory, directly beneath a 6 x 8 ft. skylight. The results reported were obtained (unless otherwise specified) on bright days, at hours when the sunlight shone directly on the skylight. A careful record of the illumination was kept, so as to ensure the most favorable as well as the most constant conditions. Most of the results were obtained in the spring, summer, and fall of 1911 and the spring of 1912. The tests made with the view of investigating the results of Ferree and Rand were carried on during the summer of 1912.

III. Observers.—Eight observers—the most highly trained in the laboratory—served in all or some of the experiments. Of these, Miss Goudge (G), Dr. Jacobson (J),[6] and the writer (D) were graduate students in psychology of two or more years' standing; Messrs. Boring (B) and Foster (F) were graduate assistants in the department; Mr. Tappan (T), an instructor in civil engineering, was carrying on graduate work in the department; Dr. Geissler (Ge) and Mr. Ruckmich (R) were instructors in psychology. All the observers possessed normal color vision. G gave warning that her experience in the Bryn Mawr laboratory had shown her to be deficient in sensitivity to after-images. R stated, at the outset, that he was highly suggestible to color.—In the last series of tests (summer, 1912), R, F, and Professor Baird of Clark University served as observers.

Method

I. General Procedure.—In general the method of procedure was essentially that of Fernald.[7] *O* was seated in a chair, whose height was adjustable, in front of the Hering head-rest, which was itself placed in front of the campimeter screen (as described above). The rotation-device was adjusted for the distance between his eyes; the Hering head-rest was set for the given observer (the settings were determined once for all, before experimentation was begun); *O*'s biting-board was

[6] J showed extreme liability to eye-strain and was, therefore, soon discarded.

[7] *Psychol. Monog.*, X, No. 3, 1909, 19, 20.

placed in position. The black velvet eye-shade was adjusted to cover *O*'s left eye. He then verified the accuracy of his position by making sure that a circle on the middle of the stimulus screen did not change its position, with reference to the opening in the campimeter screen, on rotation of the Hering head-rest. Inasmuch as the head-rest could be rotated to any angle, *O* was now prepared to take any fixation, without thereby incurring the slightest amount of eye-strain. There was, of course, no way of avoiding the eye-strain aroused by long-continued fixation; but the device gave us a signal advantage over Fernald's arrangement, which provided for only one position of the biting-board.

There was no further allowance of time for achromatic adaptation. Sometimes, however, *O*'s adaptation was tested by the presentation of grey stimuli. The regular experimental series (presentation of the ten colors and black and grey in haphazard order) then ensued. *O* took the desired fixation, and tapped on the table. *E* gave the signal "ready," and immediately raised the stimulus screen,[8] exposing the chosen stimulus. After an exposure of 5 seconds (determined by the stop-watch) *E* gave a signal "now," and, after a moment, lowered the stimulus screen over the stimulus. In case the color seen by *O* disappeared before the five seconds were over, *O* signalled by a tap to *E*, who immediately lowered the screen. *O* held his fixation until all traces of the after-image had disappeared, waiting, as a rule, some time longer for certainty. *O* was now required to report in full on the hue, tint, and chroma of both sensation and after-image. He was shown a duplicate of the small-sized Hering *Farbenkreis* and was asked to place the colors experienced among those of the Hering series; if a color fell between two adjacent colors of the circle, it was so designated, emphasis being given when possible to the predominant component. *O* was also required to note other experiences connected with the color, *i. e.*, number of recurrences and relative duration of after-images, changes in hue in either sensation or after-image, color seen during the fore-period of a given test, eye movement during prescribed fixation, eye-strain, inattention. For a number of experiments *E* carefully watched *O*'s eyes, so as to note the occurrence of perceptible eye movement. *E* kept a record of all such relevant data, as well as of the report proper. In case *O* reported a color during the fore-period, the time-interval was lengthened; otherwise, the next stimulus was presented two minutes (or more) after *O* removed his teeth from the biting-

[8] The prefixation period was thus minimal.

board; the interval was recorded by stop-watch, and the exact time was recorded by *E*.

II. Methods.—Two main lines of method (A and B) were laid out. In the first (A), the ten Hering colors and platinum grey and black were presented in haphazard order as stimuli. The backgrounds were platinum medium grey, Hering velvet black, and platinum white.

A 1. The first experiments were performed with the platinum grey as background and projection ground (*i. e.*, screen on which the after-image was projected). This background, it was thought, would be the most favorable for both sensations and after-images, and would therefore serve as a fairly easy introduction to the more difficult work with black and white backgrounds. Sets of results, at fixations from 20 to 90 degrees, were obtained (with some gaps) from five observers. In the first part (*a*) the Hering colors mounted on cards were used as stimuli. At the start they were presented to the observers, at fixations from 55 to 90 degrees (this was our interpretation of Fernald's "more peripheral points"), as long as any color was seen. This time, however, was found to be too long; the observers soon complained of eye-strain. The exposure time for all fixation-points was then arbitrarily fixed at 5 seconds (or less, if the color disappeared within that time). In the second part (*b*) certain Hering colors, mixed with varying amounts of black or white, were presented as stimuli. Some observations were also made (*c*) in which the individual after-images of Hering colors were projected successively on different backgrounds.

A 2. The Hering velvet black was next used as background. (*a*) Full sets of results (20 to 90 degrees fixation) were obtained with six observers for the ten Hering colors. (*b*) Observations were also made by three of these observers, for fixations from 60 to 90 degrees, with the black background and the platinum medium grey as projection ground.

A 3. The platinum white background was reserved until last, in order that the observers might have the advantage of a year's training. This background, it had been asserted, was the most favorable to "colored after-images from unperceived stimuli." To it therefore we devoted the most time, taking, with the white background and projection ground (*a*) some 1,700 observations from five observers (as compared with 650 for platinum grey and 1,100 for Hering black). The majority of the results were obtained at the more peripheral fixation points. Additional sets were taken under special conditions with (*a'*) the attention variously directed (*i. e.*, sometimes on the stimu-

lus, sometimes on the after-image) and with (*a''*) variations of the time interval between experiments. Results were also obtained (*b*) from two observers, with the white background and black projection ground. Only a few tests—because the method proved too fatiguing—were taken (*c*) in which the observer fixated the white ground for some time (5, 10, or 15 seconds) before exposure of the stimulus, thus mixing the dark after-image of white with the stimulus.

In the second part (B) of the problem, the aim was to determine (1) the *Urfarben* and (2) their limits for the different backgrounds. Mixtures of Hering red, blue, green, and yellow, and black and white were the stimuli. Our present procedure differed from that of A, in that we now presented a single stimulus continuously, starting at either 0 or 90 degrees fixation, and taking successive fixations to 90 or 0 degrees respectively. Our method was essentially that of Fernald.[9]

Results

General Interpretation of Tables.—Inasmuch as frequent use will be made of tables it may be well to give here a general interpretation of the symbols used. The colors are always indicated by their corresponding initials (R = red, OR = orange-red, BG = blue-green, BlG = bluish green, etc., of the Hering series). The symbols for two colors connected by a hyphen indicate a color the hue of which lies between the two hues indicated; if the one component is predominant the corresponding symbol is italicised. A line —— is used to indicate colorless sensations or after-images. The numerical subscripts under color symbols indicate the number of times of occurrence.

I. Effect of Background on Sensation

A. Changes in Hue

1. With Medium Grey Background

Table I gives a representative account of the course of the sensations from the ten color stimuli. It will be seen that here (as in the case of the other observers): (1) sensations from the red stimulus undergo little change from 20 degrees to 90 degrees of fixation, shifting only slightly toward orange; (2) with the orange we have a decided shift through orange-yellow practically to yellow; (3) orange-yellow becomes yellow at the extreme periphery; (4) yellow soon loses its slightly

[9] *Psychol. Monog.*, X, No. 3, 60.

greenish cast, but is otherwise constant; (5) yellow-green passes through greenish-yellow to yellow; (6) green shifts quickly toward yellow and is soon colorless; (7) blue-green passes through greenish blue toward blue; (8) blue is fairly constant; (9) violet becomes blue; and (10) purple passes through violet to blue. Thus red, orange, orange-yellow all shift (the amount depends roughly on the proportion of yellow in the stimulus) toward yellow; while blue-green, violet and purple shift toward blue. In both cases the green component

TABLE I

O—B Grey Background.

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
90	—	Y? Y-OY	Y	Y	—	—	—	—	—	—
85	—	Y-OY	*OY*-O Y	Y	Y-GrY Y	—₂	—₀	B	B	B B? —
80	O R	Y-OY₂	Y	Y	Y-OY	—	B	B	B	—
75	*OR*-O OR	Y-OY	*O*-OY OY	Y *Y*-OY	Y	—	GrB	B	B	—
70	OR	*O*-OY	*Y*-OY	Y	Y	—	GrB	B	B	*V*-P
65	OR	O	Y	Y	Y	—	OY-O	B	B	P
60	OR-R	*O*-OY	OY	Y	Y	—	GrB-B	B	*B*-V	P-V
55	O₂	OY	*OY*-O	Y-OY	Y-GrY	YG	B-GrB	B	B	P
50	*OR*-R	O	*OY*-O	Y	Y-GrY	YeG	GrB	*B*-GrB	B-V	P
45	R	*OR*-O	O	Y	YG-Y	YeG	GrB	B	*V*-B	*V*-P
40	*OR*-R	O	OY-Y	Y	YG-GrY	YeG-YG	GrB-BG	B	*V*-P	P
35	R	O	Y-GrY	Y	GrY-Y	YeG	GrB	B₂	B	P
30	R-PR	O	OY-Y	Y	GrY-Y	G	BlG	B	*V*-P	P
25	R-PR	O	OY	Y	YG-GrY	YeG	BlG	B	V	P
20	OR	O	OY	*Y*-OY	YG-GrY	BlG	BG	B	*V*-P	P

tends to disappear first, before the red, a fact that we may reasonably attribute to the poorer saturation of the green.

2. With Hering Black as Background

Table II is typical of the course of the sensations from the ten colors, with the black background. (1) Red shows a rapid and pronounced shift toward yellow, becoming finally orange-

TABLE II

O=D Black Background.

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
90	OY OY-O	OY-O OY	OY-O$_3$	OY$_2$	OY Y	—$_2$ Y	B-GrB GrB?	B-GrB$_2$ GrB-B	B-GrB B-V	GrB-B —
85	OY-O$_2$	O-OY	OY-O$_3$	OY O-OY	Y-OY	B? —	GrB-B GrB	GrB-B V	B GrB	GrB V
80	OY-O Y-OY O-OY	OY-O$_2$ OY	O-OY OY-O OY	OY Y-OY$_2$ Y	OY-Y$_2$ Y-OY	Y-OY Y	B GrB	B$_2$	B$_2$	B-V B GrB
75	O-OR OY-O	O OY	Y	OY-O OY	O-OY$_2$ OY	—$_2$	V? GrB	B$_2$ GrB	B B?	P-V GrB
70	O-OR OY-O	GrB	OY-O OY	O-OY Y-OY Y	OY Y-OY Y	—$_2$	B-V GrB	B$_3$	B$_2$	P+B BG
65	O-OR O	O-OR OY-O$_2$	OY-O Y-OY OY	OY-O OY Y	O-OY Y	OY-O —	BG GrB$_2$	B$_3$	B-V GrB-V	B+P P-PR
60	O-OR O	OY-O OY	OY-O Y	Y$_2$	Y-OY Y	Y —	BG-GrB GrB	B$_2$	B$_2$	B P
55	O-OY	OY-O	OY	Y	Y	Y	GrB	GrB	GrB	P-V
50	O-OY	OY-O	OY	Y	Y	Y	GrB	B	V-GrB	P-V
45	O	OY-O	OY	Y	Y	Y	GrB	B	B-V	P
40	O	O-OY	OY	Y	YG-GrY	GrY	GrB	B	V-B	P
35	O-OY	OY-O	Y	Y	YG-GrY	Y	BG	B	V-P	P
30	O-OR	O	OY	Y	YG	YeG	BG	B	V-B	P
25	O-OR	O	Y	Y	YG	G	BG	GrB	V-B	P
20	O	OY-O	OY	Y	GrY?	BlG	BG	GrB	GrB	P-PR

yellow at 90 degrees; (2) orange follows a similar course; (3) orange-yellow is fairly constant, showing a slight shift, in some cases, toward orange (with D and R), but generally to yellow; (4) yellow is also fairly constant, though it loses its greenish cast and shifts as a rule toward orange-yellow; (5) yellow-green passes rapidly through greenish yellow to yellow; (6) green soon becomes yellow, which is seen only intermittently at the extreme periphery; (7) blue-green quickly shifts to greenish blue and, with some observers (B and T), to blue; (8) blue is intermittently blue or greenish blue throughout the series; (9) violet shifts gradually toward blue, as also (10) does purple. Thus, the change with red, orange, orange-yellow, yellow-green, and green stimuli is toward yellow; while that of blue-green, violet and purple is toward blue.

3. With the Platinum White Background

Table III has been selected as fairly representative of the results obtained with the white background and projection ground. It shows the general trend of the colors. With this background, however, there is greater variability in the observers, and also in the results for a single observer, than with the other two backgrounds. Because of this variability, special additional tables IV-VIII have been prepared, which represent respectively the results from red, orange, orange-yellow, yellow, and yellow-green, for all the observers. (1) Red is fairly constant, changing only slightly in the direction of yellow; (2) orange is almost as constant, but shifts somewhat toward red; (3) orange-yellow changes also toward red, though it only occasionally shifts beyond orange; (4) yellow soon loses its decidedly greenish cast and changes in the direction of red; it almost never, however, shows a shift beyond orange; for G and B it is practically constant, and for the other observers it shifts generally only to orange-yellow; (5) yellow-green passes through greenish yellow and yellow to orange-yellow; for B it then shifts almost to orange; for F it becomes even more reddish; for the others (D, G, and R) it practically remains slightly on the yellow side of orange-yellow; (6) green shifts through yellowish green, yellow-green, and greenish yellow to yellow; it is then usually colorless, but is sporadically seen as orange-yellow, orange, or a color between orange and orange-red; (7) blue-green changes to greenish blue or blue; it is even occasionally seen on the periphery as bluish green; (8) blue is fairly constant; (9) violet becomes blue for all except F, for whom it is sometimes violet; (10) purple likewise becomes blue for all except F, for whom it is

TABLE III

O=F White Background.

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
90	—	—	—	—₂	—	—	B-V B?	*B*-(V) V	V_2 —₂	—
85	—	—	—	?-Y-?	—₂	—₂ OR-O	—₄ B V	*B*-V *V*-B	—	—
80	—₂	OR ! O-OR	O-OR_2 O_2	OY? —	—₂ *O*-OR O-OY	—₂	— B	B_2 V-B *V*-P_2	— B? V_2?	B? V_2
75	— OR O-OR_2 O?	O-OR_2	O-OR O	O-OR	O-OR	— OR?	B V-B	GrB B-GrB V-B	V V? BG	V? B-BG?
70	OR	O-OR	OY-O	*GrY*-Y	—₂ OY-Y_2? Y?	—	*B*-V *V*-B	*V*-B BG	*V*-B GrB	—₂ *B*-V_2 V
65	—	*OR*-O	OY-O	?-Y-?	OR-O_2 *OY*-O O_2 GrY or OY	OY-O	V	V	V	—₄
60	O-R	*OR*-O	O-OR	O-OY	OY or GrY-YG	—₁₀	B-GrB	B-GrB	V	V_2 *V*-P
55	OR	O-OR	O-OR	Y-OY	?-Y-?	—	B	B	B	V
50	OR-O	*OR*-O	OR-O	*GrY*-YG	*YG*-GrY	—	GrB	V	V	P-V
45	OR	O-OR	O *O*-OR	*O*-OY	YG-YeG	YeG	B	V	*V*-P	*V*-P
40	OR	OR	*O*-OY	*OY*-Y	*YG*-GrY	*G*-BlG	*B*-GrB	B	V-B	P
35	OR	*OR*-O	*O*-OR	*Y*-OY	YG	*YeG*-YG	*BlG*-BG_2	B	V	*V*-P
30	OR	O-OR	OY	OY	YG	YeG	BG	B	V	*P*-V
25	*R*-OR	*O*-OR	O-OY	Y	YG	*G*-YeG	*BlG*-BG	B	*V*-B	P
20	*OR*-R_2 R	OR-R_2 OR	OY-O_2 OY	YG-GrY YG *OY*-Y	YeG	G YeG	BlG	B	V	P
5	R	*O*-OR	OY	Y	YG	G	*BlG*-BG	B	*B*-V	P
0	R	O	OY	Y	YG	G	BlG	B	V	P

TABLE IV

Stim.=R White Background

Fix'n. °	Observers				
	B	D	F	G	R
90	—		—		—₃
85	O —	—	—	—	—₄
80	—₂		—₂ B?	B	OR —₅
75	*V*-B —	R R?₂	— OR O? O-OR₂	R?	OR OY
70	O —₃		OR₃	—	— O
65	R	R R??	—	O	OR O
60	*O*-OR O₂ *O*-OY		O-R	Y?₂	V
55	O-OR		OR	R	O₂
50	OR		OR-O	R	R
45	R		OR	OR	R
40	*PR*-P		OR	*OR*-R	R
35	R-PR		OR	OR	R
30	R		OR	OR	R
25	*R*-OR		R-OR		R
20	R		OR-R *OR*-R R	R	OR
5	R-OR	R	R	*R*-OR	R
0		OR	R	R-OR OR	*OR*-R OR

TABLE V

Stim.=O White Background

Fix'n. °	Observers				
	B	D	F	G	R
90	—		—₂		—₃
85	—₂	—	—	—	—₅
80	—₂		O-OR OR	—	P —₄
75	— R	O	O-OR₂	O or OR? —	O Y
70	OR₂ R		O-OR *OR*-O	OY	O — OR
65	OR-O	R	*OR*-O	O	OR O
60	OR-O		*OR*-O	O	O
55	O-OR	O	O-OR	O	O
50	OR-O		OR-O	*OR*-O	OR
45	R		O-OR	O-OR OR	O
40	R-PR R		OR	O	R
35	R		*OR*-O	*OY*-O	OR
30	R-OR		O-OR	*O*-OY	R
25	OR		*O*-OR		R
20	O OR		*R*-OR₂ OR R-OR YG?	O	O
5	*OR*-O	O	*O*-OR	O₂	O
0		O-OR OR-R	O₂	O	O₂

TABLE VI

Stim.=OY White Background

Fix'n. °	Observers				
	B	D	F	G	R
90	—		—		—₂
85	— O	?	—	—	—₂
80	—₂		O-OR₂	—₂	Y P —
75	— O	Y OY-O	*O*-OR O	*OY*-Y OY	OY — OY-Y
70	— O		OY-O	O *OR*-O	OR O
65	O	O	OY-O	OY	OR *OY*-O
60	O₂		O-OR	Y	O
55	OY-Y	*OY*-O	*O*-OR	*OY*-O	O
50	O		*OR*-O	*OY*-O	OR
45	*O*-OR		O *O*-OR	*Y*-OY	OR
40	O		*O*-OY	*OY*-O	O
35	O		*O*-OR	OY	OY
30	OY		OY	OY *O*-OY	O
25	O-OY		O-OY		O
20	OY		OY OY-O₂	OY	OY
5	OY	OY₂	OY	OY	OY
0		OY	OY	OY₂	OY₂

TABLE VII

Stim.=Y White Background

Fix'n. °	Observers				
	B	D	F	G	R
90	— B		—₂		—₂
85	—₂	—	-Y-?	B? —	—₂ V
80	— Y		— OY?	Y	Y₂ — O GrY
75	— O	Y-OY	O-OR	Y₂	Y GrY
70	Y —		*GrY*-Y Y	Y	O Y₂ —
65	*Y*-OY	OY₂	-Y-	Y	O Y
60	Y₂		O-OY	Y₂	O
55	Y	OY	Y-OY	Y	OY
50	*Y*-OY		GrY-YG	Y	OY
45	Y+OY		*O*-OY	Y	Y
40	OY-Y		*OY*-Y	*Y*-OY	Y
35	Y		*Y*-OY	Y Y-OY	Y
30	Y		OY	Y	Y
25	*Y*-OY		Y		Y
20	*Y*-OY *Y*-GrY		YG-GrY YG *OY*-Y	*Y*-GrY	Y
5	Y	Y	Y	*GrY*-YG	Y
0		Y	Y	*GrY*-Y *Y*-GrY	Y₂

TABLE VIII

Stim.=YG — White Background

Fix'n. °	Observers				
	B	D	F	G	R
90	— R? B?		—		—₃
85	—₃	— Y	—₃	B or P?	—₄
80	—₇ R		—₃ *O*-OR O-OY	B?	—₃ Y
75	—₃	OR-O	—₃ O-OR O? O-OY Y	O	—₁₂ Y₃ P-R₆ O? Y or G
70	O-OY OY O —		OY-Y?₂ —₃ Y?	Y	—₃ O
65	OY	*OY*-Y	OR-O₂ O *OY*-O GrY or OY	Y	R OY
60	Y *OY*-O		OY or GrY-YG	Y₂	O
55	— Y	*Y*-OY	-Y-?	Y	OY
50	*GrY*-YG		YG-GrY	Y	—
45	YG		YG-YeG	Y	YG
40	YG		*YG*-GrY	GrY	YG
35	YG		YG	GrY	YeG
30	YG		YG	GrY-Y	YG
25	YG		YG		G
20	YG		YeG	GrY	YeG
5	YG-YeG	YG	YG	YG	YG₂
0		YG	YG	YG	YG *YG*-YeG

occasionally violet. Thus, red shows a very slight change toward yellow; orange, orange-yellow, yellow, and yellow-green change in the direction of red; green becomes yellow (possibly reddish); blue-green, blue, violet, and purple become blue.

4. Comparison of Results for the Three Backgrounds

a. Effect on hue

A comparison of the results for the different backgrounds shows that: (1) the effect on red is practically the same with the grey and the white grounds (a slight shift toward yellow); the shift toward yellow is much more marked with the black ground; (2) orange, orange-yellow, yellow, yellow-green, and green all shift toward yellow with the grey and the black grounds, and toward red with the white ground; (3) blue, blue-green, violet, and purple tend to become blue with all three backgrounds; blue-green and blue have, however, a slight tendency to appear greenish blue with the white background; and blue, violet and purple may change slightly toward violet with the black background.

b. Effect on limits for colors

The results give also a rough indication of the effect of background on the limits for the different hues. Table IX gives the estimated mean values for all observers, with each of the backgrounds, of the limits for(*a*) the 10 colors seen as such, and for (*b*) the 10 different colors seen (as Vorfarben). Considerable variation is shown. With the grey ground the order of extent of the colors is: (*a*) B, R and OY, O, Y, P, BG, V, G, YG; (*b*) Y, B, OY, O, R, V, P, BG, G, and YG. With the black ground the order is: (*a*) B, OY, Y, O and P, G, BG, R, YG and V; (*b*) B and Y, OY, O and P, BG, G, V and R, YG. With the white ground the list runs: (*a*) B, R, Y, OY, O and G, BG, V and P, YG; (*b*) B, R and O and Y, OY, P, V, BG, G, YG. The variations between (*a*) and (*b*) are obviously due in large measure to differences in chroma and tint of the colored papers. Comparing the three backgrounds, we find that results from the grey are in general intermediary between those from the black and those from the white. The white ground shows the widest limits for red, orange, and blue-green; the black for the other colors.

c. Comparison with Fernald's Results

The results obtained thus far differ in some details from those of Fernald. (1) Red with the white background is not "more carmine at the outer limits than at the center;" the tendency is rather for it to be, if anything, slightly more car-

TABLE IX

LIMITS FOR COLORS

Backgrounds

Stim.	*a*			*b*		
	Grey	Bk.	Wh.	Grey	Bk.	Wh.
R	70	35	75	70	50	80
O	65	70	45	75	70	80
OY	70	75	50	80	85	75
Y	60	85	70	90	90	80
YG	30	30	25	40	40	35
G	40	50	45	40	55	45
BG	50	45	60	45	50	60
B	85	90	80	85	90	85
V	45	50	35	65	60	60
P	55	70	35	60	70	70

mine at the center. (2) Orange-yellow and yellow show in general a less marked change toward red than in Fernald's results; her observers perceived orange-yellow as red as far out as 95 degrees; we seldom found it to change beyond orange; none of our observers saw yellow (as two of hers did) as red on the periphery. (3) Fernald gives no statement of results with yellow-green and blue-green, nor for green with the black background. (4) With the black background, violet and purple were not seen as such at the extreme periphery, as was the case with her observers; instead, they tend to shift toward blue.

5. Results of Mixing Black or White With Colored Stimuli: Grey Background

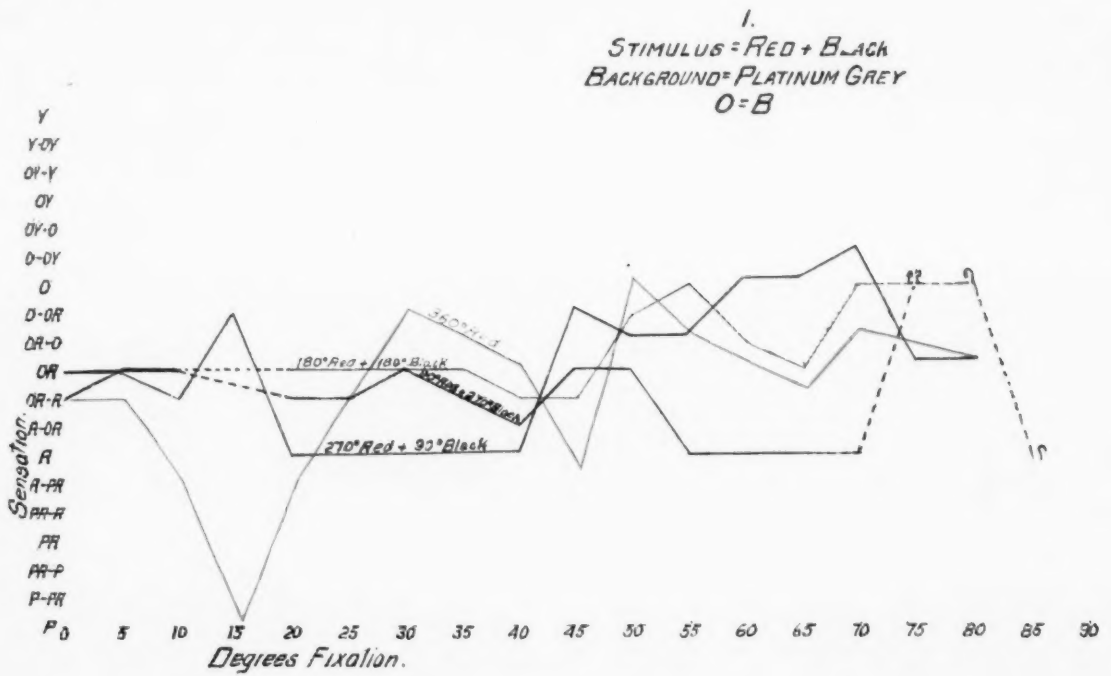
Different amounts of black or white, mixed with colored papers on an electric color mixer, were presented as stimuli at all the fixation points, with the grey background, in order that we might determine how far the results with different backgrounds might be duplicated with a single background, by actual measurable physical mixture of colors with light.

Samples of the results are shown in the form of graphs (1-4). In this case, a single color, mixed with black or white, was exposed successively at fixations from 90-0 degrees. (It was found, incidentally, that a saturated red stimulus tended to appear less red on the periphery, when rotated, than it had in general in the haphazard tests with cards; the results for red mixed with a light were, therefore, compared with those for the rotated, saturated red presented under the same conditions.) Red, orange, orange-yellow, and yellow-green, when mixed with black, show very much the same effect, from darkening, as results from the darkening of the stimulus by contrast with a light ground, or by superposition of a dark after-image on the stimulus. These colors appear more red at the periphery as the amount of black is increased; similarly they appear more yellow at the periphery as the amount of white mixed with the stimulus is increased. Blue, violet, and purple change toward blue (or greenish blue) when darkened, and toward violet when mixed with white. Green slightly bluish at the center when darkened becomes bluer, but decreasingly so as the amount of black is increased.

6. Changes in Hue during Fixation

In addition to the general shift of color tone from the center to the periphery, the observers reported frequently a shift in hue of a single color during fixation. There are marked individual differences in the number of changes reported, due partly to the fact that such changes were reported earlier in the work by some observers and were not specifically asked for by the experimenter until they had been spontaneously offered a number of times, and partly to individual differences as regards stability of the colors. Thus R, who seems to show great sensitivity to color,—when (with the grey background) the color was exposed as long as the sensation lasted, he often saw a color at the periphery for over a minute, and his after-images sometimes lasted even longer,—reported only two changes of hue during the entire period of observation. F reported the greatest number of changes; B was a close second. Tables X-XII give sample results from different observers for the three backgrounds.

With the grey ground, (1) the orange-red, orange, or orange-yellow sensations from red stimuli tend to shift toward red; (2) sensations from orange, orange-yellow, yellow, yellow-green and green (all seen as yellow or yellowish) shift toward yellow during fixation; (3) sensations from blue-green (seen usually as greenish blue or blue) shift toward green;

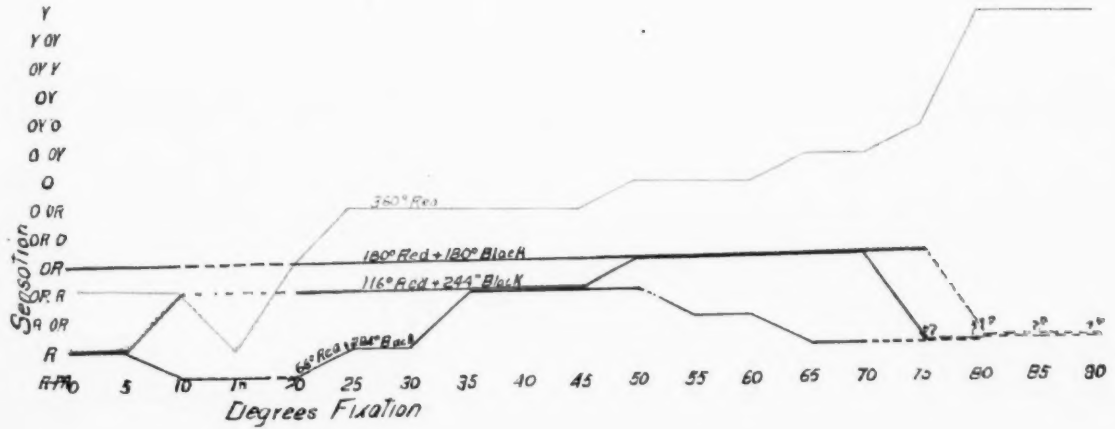

1.
STIMULUS = RED + BLACK
BACKGROUND = PLATINUM GREY
O = B
Y
Y-OY
OY-Y
OY
OY-O
O-OY
O
O-OR
OR-O
OR
OR-R
R-OR
R
R-PR
PR-R
PR
PR-P
P-PR
P
Sensation.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Degrees Fixation.
180° Red + 180° Black
270° Red + 90° Black

2

STIMNI US = RED + BLACK

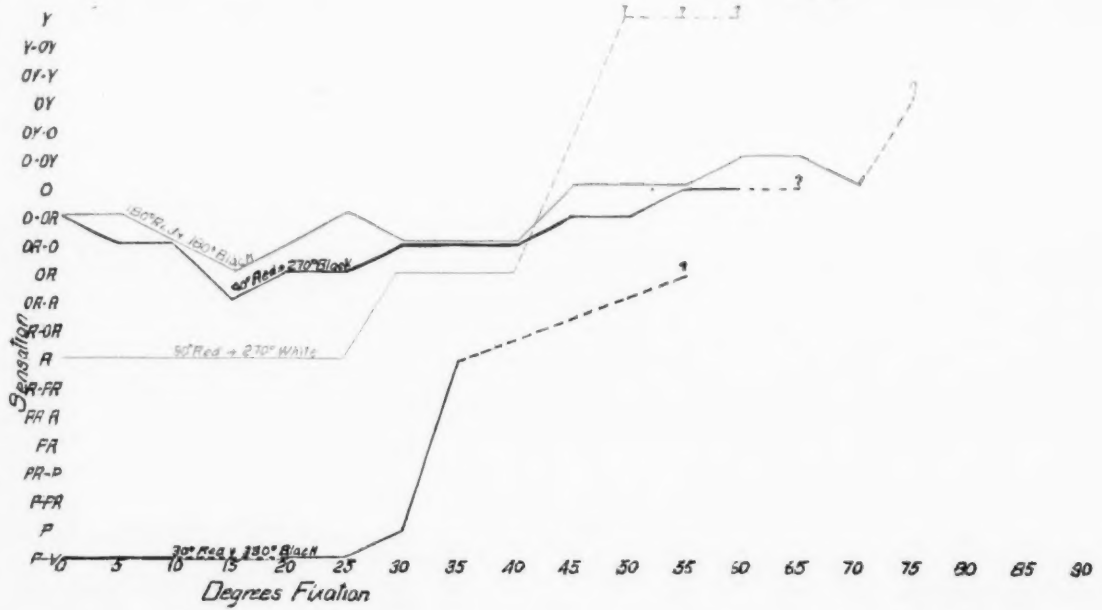
BACKGROUND = PLATINUM GREY

O = D



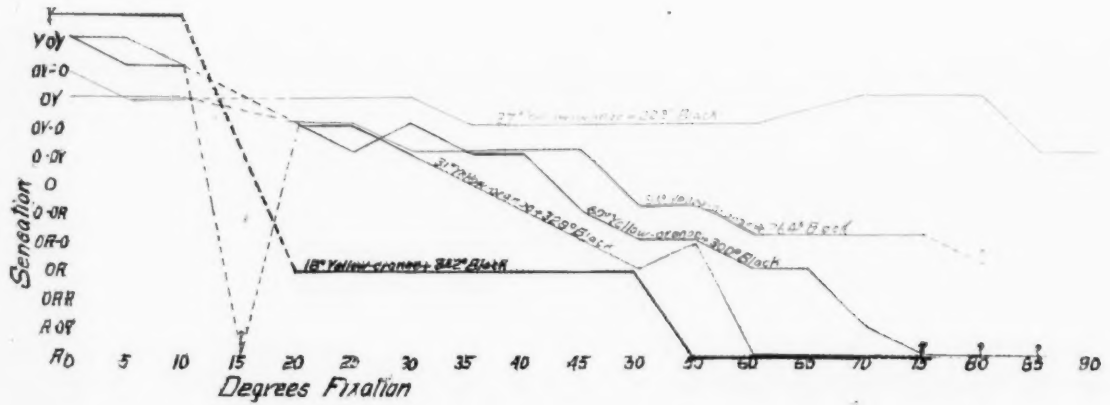
3

STIMULUS=RED+BLACK OR WHITE
BACKGROUND=PLATINUM GREY
O=G



4.

STIMULUS = YELLOW-ORANGE + BLACK
BACKGROUND = PLATINUM GREY.
O = D.



(4) sensations from blue, violet, and purple (seen usually as blue) shift slightly toward violet. The change is, therefore, toward the stimulus color with red, blue-green and violet and purple, and from it with orange, orange-yellow, yellow-green and green. In other words, sensations from red, yellow-green, green, and blue-green shift toward the red end of the spectrum, while sensations from orange, orange-yellow, yellow, blue, violet, and purple shift toward the violet end.

The case is somewhat different with the black background. Here (1) red, orange, orange-yellow, yellow, and yellow-green all change still further toward yellow; (2) green and blue-green are constant (no change was reported); (3) blue shifts toward blue-green; (4) violet and purple change toward blue. Thus, red, orange, orange-yellow, and yellow change in the direction of the violet end of the spectrum; yellow-green, blue, violet and purple shift toward the red end of the spectrum; green and blue-green are constant.

With the white background fewer changes were reported than with the other two. Here the change, when it occurred, was often too rapid for sure judgment of its direction; the colors seen were, moreover, so unsaturated that it was very difficult to pass judgment as to change in hue. In general, however, (1) red, orange, orange-yellow, yellow and yellow-green (all seen as reddish) become decidedly more red during fixation; (2) no change was reported in green; (3) blue-green, blue, violet, and purple all shift somewhat toward purple. Thus, red, orange, orange-yellow, yellow, and yellow-green shift toward red; green is constant; blue-green, blue, violet, and purple shift toward violet.

It was at first thought that these changes in hue might be due to poor fixation. If that were the case, we should expect to find the changes (1) always occurring in the direction of the stimulus, or (2) always occurring in the direction away from the stimulus, or (3) showing irregularity in direction. No one of these conditions, however, is found. Moreover, R gives evidence of occasional faulty fixation, but reports (except twice) no change in hue during the five seconds' fixation. We feel confident, therefore, that these changes represent a normal occurrence.

B. Changes in Tint and Chroma

At the center the colors are seen: (1) with the grey background, as generally medium in tint and good in chroma; (2) with the black background, as light in tint and very good in chroma; (3) with the white background, as dark in tint and

TABLE X

Grey Background

	Fix'n.	Stim.	Sensation	Change
O=B	85	OY	*OY*-O	vs. Y
	75	OY	OY	vs. Y
		Y	*Y*-OY	Y
	70	O	O-OY	Y
		OY	Y-OY	vs. Y
		P	*V*-P	V
	65	R	OR	vs. R
	60	OY	OY	vs. Y
	55	O	OY	Y
		YG	Y-GrY	vs. Y
	45	OY	O	Y
		YG	YG-Y	Y
O=*F*	85	OY	OY-Y	vs. Y
	80	OY	OY	Y
		YG	Y	vs. Y
		B	*B*-V	vs. V
	75	O	O-OY	Y
		G	GrY	Y
		R	*OR*-O	OY
	70	OY	*GrY*-YG	vs. Y
	65	O	OR	vs. Y
		OY	OR	Y-OY
		YG	GrY-YG	vs. G
		B	GrB	V-B
		O	O-OR	vs. Y
	60	O	OY	Y
	55	Y	OY	vs. Y
	50	O	OR	vs. Y
		Y	*O*-OY	Y
		Y	*Y*-OY	vs. Y
		P	P	vs. V
	45	R	*OR*-O	vs. Y
		OY	OY-OR	YG
		OY	OY-OR	vs. Y
		Y	GrY	Y
		Y	YG-GrY	vs. Y
		P	P	V-P
		V	B	*V*-B
		B	B	*V*-B
	40	R	O	OR
	30	R	O	OR
	25	BG	GrB	G-BlG

fairly good in chroma. With all three grounds, the colors become steadily darker and poorer as they approach the periphery. The change in tint is most rapid with the white ground, and least rapid with the black ground. With the latter ground, in fact, the colors become only slightly darker, fading out to

TABLE XI

Black Background

	Fix'n.	Stim.	Sensation	Change
O=B	75	O	O-OR	vs.O
		R	*O*-OY	vs.Y
	65	Y	OY-Y	Y
	55	O	O	Y
	50	O	O	vs.Y
O=F	90	Y	*OR*-O	*OY*-O
	80	R	*O*-OY	vs.Y
	70	P	P	B
	60	Y	OY	vs.Y
	55	R	OR-R	vs.O
		OY	*O*-OY	vs.Y
	50	O	*OR*-O	Y
	25	O	OR-O	vs.Y
		Y	*YG*-GrY	vs.Y
O=T	90	B	P	B
	80	R	OY	vs.Y
	75	V	P	B
	65	V	P	B
	45	R	O+OR	vs.O
	30	YG	*YG*-YeG	Y
	25	Y	GrY	Y

TABLE XII

White Background

	Fix'n.	Stim.	Sensation	Change
O=B	85	OY	O	OY-Y
	75	P	OR	O
	70	O	OR-O	OR
		OY	O	OR
		YG	OY-O	*O*-OY
		B	B	P
	65	BG	B	P
	60	R	O	*OR*-O
		YG	*OY*-O	*OY*-Y
		P	B	*V*-P
	55	R	O-OR	vs.R
	45	P	P	vs.B
	40	R	*PR*-P	B
	30	V	B	vs.V
	25	OY	O-OY	Y
	20	O	OR	vs.R
O=G	45	R	OR	R
	40	O	O	*O*-OR
		Y	*Y*-OY	Y
		P	B	*P*-V

light grey, while with the white ground they become darker at a rapid pace and pass over into black. The results with the grey ground are, as usual, intermediate; the colors fade into darker greys.

C. Variations in Duration of Sensation

As a rule, the stimuli were exposed for uniform periods of 5 seconds. It was incidentally noted, however, when longer exposures were given, that the duration of the sensations as colored was definitely correlated with the angle of fixation and with the brightness of the background. The black ground is perhaps the most, and the white ground the least favorable to persistence of sensations. With all three grounds adaptation becomes rapid as the periphery is approached. On the more extreme peripheral points the sensations show a tendency toward a flash-like appearance. This tendency is least marked with the black ground, occurring only twice (with D, for green and purple stimuli). With the grey ground, 15 occurrences of "flash" sensations were noted, at fixation points from 70 to 90 degrees, with purple (9 times), red, green, blue-green, and violet. The white ground gives the greatest number, 52 occurrences. Of these, four occur at 90 degrees, four at 85 degrees, thirteen at 75 degrees, eleven at 70 degrees, one at 65 degrees, two at 60 degrees, three at 55 degrees, and one at 50 degrees, with all stimuli, though most often with purple (9 times), blue-green (8 times), and yellow-green (7 times).

II. Effect of Background on After-Image

A. Change in Hue

1. With Medium Grey Background

With the medium grey background, the after-images of: (1) red stimuli change from bluish green at the center to greenish blue or blue, except for R, whose after-images are practically constant (blue-green); (2) orange stimuli change from blue-green (or greenish blue) to greenish blue, and finally, for B and F, to blue; (3) orange-yellow stimuli change from greenish blue to blue; with F and R they even show a tendency to shift toward violet; (4) yellow stimuli are fairly constant (blue), but shift occasionally toward violet for B, F, and R; (5) yellow-green stimuli are violet or purple at the center, but change to blue (they are occasionally greenish-blue at the periphery); (6) green stimuli are constantly purple for B, but shift to violet for F and R, and to blue for D (and

once for F); (7) blue-green stimuli change for B from orange-red to orange-yellow, and for D and R to orange; (8) blue stimuli change from orange-yellow to yellow for B and F, are fairly constant for D, and change to orange for R; (9) violet stimuli change from yellow-green or greenish yellow to yellow for all observers; (10) purple stimuli change from green to yellow for B and R, to orange-yellow for D, and to greenish yellow for F. (See table XIII for typical set of

TABLE XIII

O=F Grey Background

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
90	— B-GrB	—	—	—	B GrB-BG	—	Y	Y GrY-YG OY-Y GrY	—	—
85	—	B_2	V-B	B B-V	B-GrB	— B	Y	Y	Y	GrY?
80	GrB	GrB	B-GrB	*B*-V	*B*-GrB	—	OR-O	Y	OY	—
75	BG	GrB	*V*-B	B	B	—	OY_2	Y	Y	Y
70	GrB	GrB_2	B-V	GrB B	B	—	Y	Y	Y	GrY
65	*GrB*-BG_2	GrB	V-B	*B*-V?	V	—	OY	Y-OR	*Y*-GrY	YeG-YG
60	GrB-BG	GrB	*V*-B	V-B	B-V	*V*-B	OY	OY	*GrY*-YG	YG-YeG
55	BG	GrB	*B*-V	*B*-GrB	—	V	*O*-OY	Y	YG-GrY	YG-YeG
50	GrB-BG	GrB	*GrB*-B	B-V B?	BG *V*-P	*V*-B	*O*-OR_2	YG-GrY	*YeG*-YG	YeG YeG-YG
45	GrB BG	GrB	V *V*-B	V_2	V	V-P	OR-O	Y	YG-YeG	YG? *YG*-GrY *YeG*-G
40	GrB	GrB	V	*V*-B	V	*P*-PR	*OR*-O	OY	YG-YeG	YG-YeG
35	GrB	GrB	V-B	B	V-P	P	*O*-OR	OY-Y	YG	YeG
30	GrB-BG	GrB	GrB-B	B	*V*-P	P	*O*-OR	O-OR	YG	G-YeG
25	BlG	GrB-BG	GrB	B	*P*-V	P-PR	O-OR	Y-OY	*YG*-YeG	*G*-YeG
20	BG-BlG	GrB-BG	GrB	B	*P*-V	P-PR	O-OR	OY-Y	YG	G

results.) It is evident that there is a good deal of variability in the results; we can, however, indicate certain general tendencies. After-images whose components are blue and green change slightly toward the violet end of the spectrum; green after-images and those whose components are red and yellow shift toward yellow; purple after-images shift toward blue. If, now, we disregard the stimuli and consider the after-images merely with reference to the sensation qualities, we find that after-images of the different sensation qualities are always those that we get with the same sensations in central vision. They all, therefore, change in correspondence with

TABLE XIV

O=D Black Background

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
90	—	—	—	B	BlG?	—	—	—	—	—
85	BlG?	—	BlG?	BlG	—	—	—	—?	—	—
80	— GrB-BG	—₂	BlG BG-GrB	GrB? —	— G?	—₂	—₂	OR-O? R??	—₂	—₂
75	—	GrB-BG?	BG-GrB	GrB	—	—	—	OR-O	OR	—
70	BG-GrB	BG-GrB	BG-GrB	B	—	—	—	—	OR?	—
65	BG	BG-GrB	GrB-BG	GrB-BG B	B	—	—	OR-O	OR-O	—
60	BG	BG	BG-GrB	B	B	B	OR-O	O-OR	OR-O	—
55	BG-GrB	GrB	B	B	B P-PR	B	OR-O	OR-O	O-OR	—
50	GrB-BG	BG	GrB-BG	B	B	OR??	OR-O	OR-O	OY-GrY	O-OR
45	B	—	B	B	B	P	OR	O-OR	OY-O+YG	—
40	BlG	BlG	GrB	V	P	P	OR-R	OR+YG	O-G	YG-YeG
35	BlG-G	BlG-G	B	B	P	P	O	OY-O	YG	YG-YeG
30	BlG	BlG	B	B	P-PR	P-PR	O-OR	O-OY	YG	YG-YeG
25	BlG	BlG-BG	B	B	P	P-PR	O-OR	OY-O	YG	YG-YeG
20	BG-BlG BlG	BG-BlG	B-V GrB	B-V B	—	P-PR	*OR*-O OR-O	OY O	YG	YG-YeG

changes in their sensations, so that they are always the complementary hues to those sensations in central vision.

2. With Black Background and Projection Ground

(See table XIV for representative set of results.) Here we find that the after-images of: (1) red stimuli shift from bluish green to greenish blue, for D, and usually to blue for the other observers; (2) orange stimuli follow a similar course from blue-green to greenish blue with D, F, and Ge, and to blue with B, R, and T; (3) orange-yellow stimuli show great variability, becoming greenish with D, and remaining bluish (occasionally violet) with the others; (4) yellow stimuli show many slight fluctuating changes, so that it is impossible to say more than that they are fairly constant (blue) for all except D, for whom they incline toward green; (5) yellow-green stimuli are constant (purple) for T, and shift to blue or greenish blue for the others; (6) green stimuli shift from purple to violet for R, and to blue for the others; (7) blue-green stimuli shift from orange-red to orange for B, to orange-yellow for Ge, R and T, but are fairly constant for D and F; (8) blue stimuli shift from orange-yellow or yellow to orange-red for B, D, and T, and to orange for F, but are fairly constant for Ge and R; (9) violet stimuli shift from yellow-green or greenish yellow, to orange-red for B, D, and T, to orange-yellow for R, and to yellow for F and Ge; (10) purple stimuli change from green (slightly yellowish) to a hue between orange and orange-red for D and F; to greenish yellow for T; to yellow-green for Ge and R; and are constant for B (for all except D and F they are soon colorless). The general trend is, then, that after-images whose components are blue and green shift toward blue; purple shifts toward blue; orange-red may or may not shift toward yellow; all other after-images whose components are red and yellow or green and yellow shift toward red. If, now, we consider the after-images in relation to their sensations, we find that after-images of: (1) red sensations tend to shift from green or bluish green to greenish blue (or even blue); (2) orange sensations change from blue-green toward and even to blue; (3) orange-yellow sensations tend toward blue from greenish blue; (4) yellow sensations are usually blue or greenish blue; (5) yellow-green sensations are practically always of a hue slightly to the violet side of purple; (6) green sensations change from a reddish purple to a hue between purple and violet; (7) blue-green sensations change from orange-red more or less in the direction of yellow; (8) blue sensations remain constantly yellow

or change in the direction of red; (9) violet sensations change from yellow-green in the direction of red (once even to orange-red); (10) purple sensations tend to shift from green to yellow-green, to orange, or even to orange-red. Thus, after-images are fairly constant only for yellow-green and, possibly, blue and yellow sensations, and sometimes for blue-green stimuli.

3. With White Background and Projection Ground

Table XV gives a sample of the results for one observer. With the white background and projection ground, the after-images of: (1) red stimuli change from bluish green, at the center, to greenish blue for D and F, to blue for G, and to violet for B and R; (2) orange stimuli change from blue-green or greenish blue toward blue, becoming greenish blue for D and R, blue for F and G, and violet for B; (3) orange-yellow stimuli are constantly greenish blue for F, change to blue for D, G, and R (?), and to purple for B; (4) yellow stimuli are constantly blue for D and G, but change to violet for B, F, and R (?); (5) yellow-green stimuli change from purple or reddish purple to greenish blue for D, to blue for G, and to violet or blue for B, F, and R; (6) green stimuli change from red or purplish red to purple or violet (R); (7) blue-green stimuli change from purplish red to yellow for D and G, from purple to yellow-green for R, and from a reddish orange to yellow or yellow-green for B and F; (8) blue stimuli change for B from orange-yellow to yellow, for D and G they are constantly yellow, for F and R they become greenish yellow; (9) violet stimuli change from greenish yellow to yellow for all except F, for whom they change from yellow-green to greenish yellow; (10) purple stimuli change from yellowish green to yellow for all except F, for whom they are always somewhat greenish. The general trend is, then, that after-images whose components are blue and green become bluer (even violet); those whose components are red and yellow shift toward green, and those whose components are green and yellow change more or less toward yellow. If, now, we consider the after-images in relation to the sensation qualities, we find that after-images of: (1) red sensations change from bluish green to blue or even to violet; (2) orange sensations change from blue-green to blue or violet; (3) orange-yellow sensations change from greenish blue to blue or violet; (4) yellow sensations change from blue (or violet) toward violet (or purple); (5) yellow-green sensations are fairly constantly purple; (6) green sensations change from red

TABLE XV

O=R — White Background

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
90	—$_4$	—$_3$	—$_3$	—$_3$	—$_3$	—$_3$	YG —	—$_3$	—$_4$	—$_4$
85	—$_3$ V	—$_3$	—$_3$	—$_2$ B GrB$_2$ V$_2$	—$_4$	—$_4$ Y	—$_3$ Y	—$_2$ Y GrY-OY OY	Y$_2$	— Y
80	—$_4$ BG V	—$_3$ BG	— BG	— GrY	—$_3$ V$_2$ B	— Y	—$_3$ —	— Y$_2$	—$_2$ GrY$_2$ Y$_4$ GrY$_2$	— YG Y
75	BG	GrB	B GrB	V	V$_{10}$ B GrB P$_2$	V —	GrY	Y	Y$_{10}$ —$_3$	—
70	—	BG	B	BG	B —	—	—	Y	Y$_2$ —$_3$ GrY	—$_3$
65	V	V	GrB	BlG	—	V	Y	Y	GrY	Y$_2$
60	GrB	BG	BG	GrB	GrB	—	Y	Y	GrY	—
55	V BG	GrB	GrB	GrB	V	V	Y	OY-Y	GrY$_2$	—
50	BlG	BG	BG	GrB	V	V	Y	Y	Y	—
45	BlG	BG	GrB	B	V	V	O$_2$	Y	YG	YeG
40	BlG	BG	BG	B	V-P	P	R	Y	Y	YG
35	G	BG	BG	GrB	P	P	R	Y	GrY	YeG
30	BlG	BG	BG	V	V-P	V	OR	Y	YG	YG
25	G	YeG	GrB	V	P	V	P	Y$_2$	GrY	YeG
20	BG	BG	GrB	P	P	P	P	Y	GrY	YeG
5	—	BG	GrB	V	V	—	P	Y	—	GrY
0	BG	BG	BG	V	V	PR	—	Y	Y	YeG

or purplish red toward purple; (7) blue-green sensations change from purple-red or orange-red toward yellow-green; (8) blue sensations are constantly yellow (or become greenish yellow); (9) violet sensations are yellow-green or greenish yellow at the center and shift toward yellow; and (10) purple sensations shift from yellowish green or green to yellow-green or greenish yellow or even to yellow. Thus, the after-images are never constant for their stimuli, and are fairly constant only for yellow-green (purple) and possibly for blue (yellow) sensations.

4. With Black Background and Grey Projection Ground

Table XVI gives the results with the black background and grey projection ground for the same observer (D) whose results with the black background and projection ground are given in Table XIV. It may be sufficient to note that the results are quite different for the two projection grounds, especially for blue-green, blue, violet, and purple stimuli. There is, however, very close agreement with the results for the grey background and projection ground.

TABLE XVI

O—D

Black Background
Grey Projection Ground

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
90	GrB	GrB?	B?	B	GrB?	—	Y?	OY Y	OY	—
85	GrB	GrB	B GrB-BG	GrB?	GrB	—	Y-OY	OY	O-OY	Y-OY
80	GrB	GrB	GrB	GrB	BG	—	OY-O	Y	OY	Y
75	GrB	GrB	GrB	GrB	GrB-BG GrB	—	OY	OY-O OY	OY	Y
70	GrB	OY	GrB	B GrB-B	GrB_2	—	OY-O	Y-OY OY	Y	Y?
65	GrB-BG	B-GrB GrB-BG V-P	GrB_2	GrB	GrB-BG	—	Y Y?	Y-OY OY-O	GrY	—
60	BG-GrB	GrB	B GrB	B GrB	B	—	OY+GrY	Y-OY	Y	Y

5. With White Background and Black Projection Ground (See Tables XVII and XV for sample results with this

TABLE XVII

O=R

White Background
Black Projection Ground

Fix'n. °	Stimuli									
	R	O	OY	Y	YG	G	BG	B	V	P
85	—	—	—	—	—	—	—	—	—	—
80	—	—	—	GrB B	—	—	—	—	—	—
75	BlG	B	GrB	B	—	—	—	—	—	—
70	GrB	B	B	B_3	—	—	—	O	—	—
65	GrB	B	GrB	B	GrB	—	—	O	—	—

method, and with the white background and projection ground.) As in 4, the results seem primarily dependent on the brightness of the projection ground. Here, the blackness of the projection ground is, evidently, enhanced by contrast with the white background; quite consistently, we find the results in this case showing an exaggeration of those with the black background and projection ground.

6. Comparison of Results for 1-5

A comparison of the results for the various combinations of background and projection ground brings out, first, the very evident fact that it is the difference in brightness of the projection ground that is responsible for the difference in the courses of the after-images. It is plain also that the after-image hues show the same dependence on brighteness that the same hues do when experienced as sensations. If, however, we try to find a definite correlation between stimulus or sensation (or both) and after-image for all backgrounds, we find an apparent lack of uniformity. In the case of the grey ground alone is there anything like consistency. Here we see that the hue of any after-image may be incidentally the complement of its stimulus, but is *always* the complement of its sensation. The medium grey thus seems to present a standard set of conditions with which to compare those of the black and white grounds. Dealing first with the black ground,

as compared with the grey, we note that the most peripheral after-images of: (1) red stimuli (bluish green at the fovea) are slightly greener; (2) orange stimuli (blue-green) are practically the same (slightly greener); (3) orange-yellow stimuli (blue) are as a rule greener; (4) yellow stimuli (blue) are practically the same (possibly greener); (5) yellow-green stimuli (violet or purple) are practically the same; (6) green stimuli (purple) are practically the same (possibly bluer); (7) blue-green stimuli (orange-red) are redder; (8) blue stimuli (orange-yellow or yellow) are redder; (9) violet stimuli (yellow-green or greenish yellow) are redder; (10) purple stimuli (yellowish green) are redder. We find, on the other hand, if we compare the results for the white ground with those for the grey, that, for the former, the most peripheral after-images of: (1) red stimuli (bluish green) are redder; (2) orange stimuli (blue-green) are slightly redder; (3) orange-yellow stimuli (between greenish blue and blue-green) are practically the same (usually redder); (4) yellow stimuli (blue) are perhaps redder; (5) yellow-green stimuli (purple) are redder; (6) green stimuli (purple) are redder; (7) blue-green stimuli (orange-red) are distinctly greener; (8) blue stimuli (orange-yellow or yellow) are distinctly greener; (9) violet stimuli (yellow-green or greenish-yellow) are greener; (10) purple stimuli (yellowish green) are perhaps greener. The results from the black and white grounds are thus seen to show opposite trends with reference to the grey background. They seem, moreover, to correspond closely with the results that ensued in the case of the sensations, where: (1) darkening of the stimuli made red, orange, orange-yellow, yellow, yellow-green, and yellowish green all shift toward red, and made bluish green, blue-green, blue, violet, and purple all shift toward green; while (2) lightening of the stimulus made red, orange, orange-yellow, yellow, yellow-green, and yellowish green all shift toward green, and bluish green, blue-green, greenish blue, blue, violet, and purple shift toward purple. In other words, darkening sensations or after-images makes them shift toward the red end of the spectrum, lightening causes a shift toward the violet end. Taken as a whole, the results suggest that (1) we have in every case, no matter what the brightness of the background may be, the same processes in the retina for a given stimulus at a given fixation (namely, the processes resulting with use of the medium grey background); that (2), however, the simultaneous occurrence of the black or white process results in a tendency for the colors experienced to shift in a definite spectral direction.

It is hardly possible to compare our results with those obtained by Fernald, since these are given in too little detail. We must assume, from such statement as she makes, that her concern with them was comparatively slight; and we think that her method was evidently not calculated to bring out fine details.

7. Effect of Changing Brightness of Projection Ground for the Same After-Image

(See Table XVIII for results.) This method was not always successful, in that sometimes the double movement across the field was distracting, and therefore only one after-image was noted. When, however, the two colored after-images were obtained, they showed changes in hue which were characteristic for their projection grounds. Thus, when the change is from a light to a dark background, the after-images whose components are blue and green shift toward green, those whose components are red and yellow shift toward red, as also do those whose components are yellow and green. A consistent change in the opposite direction occurs when the change of background is from dark to light. These results are also consistent with the view that the same retinal processes for color occur even when the resulting sensations or after-images are different.

8. Changes During Fixation

As in the case of the sensations, so the observers showed a tendency to report changes in the hue of the after-images during fixation. Sometimes the after-images which fluctuated recurred as different in hue; often, also, persistent after-images underwent a gradual change in color tone. Tables XIX-XXI give typical results. Here, as with the sensations, the changes are fairly consistent for given projection grounds. With the white background they occur only with the red, orange, orange-yellow, yellow, and yellow-green stimuli; the shift is always toward the red end of the spectrum. There is less uniformity in the cases of the grey and black backgrounds; though this result may be due to the poorer saturation of these after-images, and to the correspondingly greater difficulty of judging changes in hue. In general, however, with the black background, the after-images of red, orange, orange-yellow, yellow and (usually) yellow-green stimuli shift toward the violet end of the spectrum; and those for green, blue-green, blue, violet, and purple stimuli change toward the red end of the spectrum. With the grey background, after-images of red, orange, orange-yellow, yellow, and yellow-green

stimuli shift toward the red end of the spectrum; and those for green, blue-green, blue, and violet shift toward the violet end. Thus, with the white background, after-images on the green-blue-violet half of the spectrum shift gradually toward the

TABLE XVIII

Grey Background

O	Fix'n.	Stim.	Sensation	After-images		
				Grey P. G.	Black P. G.	White P. G.
D	85	Y	OY	GrB-BG	(1)BlG	
		P	B?	(1)Y	OY	
	80	R	*O*-OY	(1)GrB-BG	BG??	
		OY	Y	GrB	(1)BlG	
G		B	B	*OY*-Y		(1)Y?
D	75	O	*OY*-O	(1)GrB	BG-GrB	
	70	OY	*OY*-Y	(1)B	BG?	
		YG	Y	GrB	(1)GrB-BG	
R		B	B		OR	(1)Y
B	65	O	OY-O	PR?	(1)V?	
D		V	B	(1)*GrY*-YG	OR	
		V	B	*GrY*-YG	*R*-OR	
		V	B	Y-GrY?	(1)OR	
		V	B		OR	(1)GrY
		V	B		(1)OR-O	Y?
		BG	GrB-BG	(1)GrY	R-OR	
		BG	GrB-BG	YG?	(1)OR	
	60	BG	GrB-BG		OR	(1)Y
F		YG	OY; GrY-YG		GrB-BG	(1)*P*-V
B	55	B	B	*O*(-OR)	(1)*OR*-O	
D		YG	Y	BG		(1)B(-V)
	50	O	OY-O	GrB	(1)BG	
B	45	B	GrB	OY	*OR*(-O)	
		B	B	Y-OY		(1)GrY
		B	GrB		O	(1)Y
		B	B		(1)O	Y
D		P	P	(1)YG-GrY	OR-O	
	40	YG	YG-GrY	(1)P-V	B	
		YG	Y-GrY	*P*-V	(1)B	
		YG	GrY-Y	(1)P-V	GrB-BG?	
G		B	B	Y	(1)*O*-OR	
		B	B	(1)Y	OR	
		B	B		OR	(1)Y
		B	B	O		(1)Y
		V	B	(1)Y	OR	
		P	*P*-PR		Y-GrY	(1)Y
	30	P	P	(1)YG		Y?
		P	P	YG	(1)G	
B	25	G	G-BlG	PR	(1)*P*-PR	
F		YG	YG	PR-P?	(1)*V*-P	
D	20	O	OY-O	BG	(1)BG-BlG	

red end of the spectrum; the others are presumably constant. With the grey background, after-images on the green-blue-violet end of the spectrum shift similarly, though less markedly, toward the red end; those on the red-yellow-green half shift toward the violet end. With the black background, after-images on the green-blue-violet half of the spectrum change toward the violet end; those on the red-yellow-green half shift toward the red end. Inasmuch as the chroma of the after-images always becomes poorer, it is conceivable that the difference in results for the white and black grounds as compared with the grey is due to the difference in direction and amount of the change in brightness (which is, of course, toward middle grey).

B. Changes in Tint and Chroma

The tint of the projection ground has a marked effect on the tint of the after-image. All observers show the same general trend. The after-images are lightest with the white background and darkest with the black. With the grey ground they are about medium in tint at the center (those for green, blue-green, blue, violet and purple are rather lighter), and become slightly lighter; with the white ground they are light, and grow steadily lighter; with the black ground they are dark (with the same variations as with the grey), becoming darker toward the periphery.

As regards chroma, the results hardly warrant more than the

TABLE XIX

Grey Background

	Fix'n.	Stim.	Sensation	A. I.	Change
O=D	85	OY	OY-O	B	GrB-BG
	80	OY	*Y*-OY	B-GrB	vs.G
	70	OY	*OY*-Y	B	GrB
		O	OY...O	B-GrB	BG-GrB
		YG	OY-Y	GrB	BG
	65	YG	Y	B	GrB
		OY	*OY*-Y	B	B-GrB
	60	OY	OY-O	B	GrB
		Y	Y	B	GrB
O=R	70	B	GrB	OY	O
	65	O	*O*-OR	B	*P*-V
	60	YG	Y	BG	V
	55	BG	B	O	OY
		G	Y	B	V
		Y	Y	B	BG
		OY	O	B	GrB

statement that the black ground is least favorable to peripheral after-images. The white ground appears to be most favorable to peripheral after-images, especially to those from blue stimuli. The observers show decided individual differences with regard to chroma; thus R's after-images are comparatively good, while F's are always poor.

TABLE XX

Black Background

	Fix'n.	Stim.	Sensation	A. I.	Change
O=B	50	YG	Y	B	P
	35	Y	Y	P-PR	V
		YG	Y	P	B
	30	R	R	G	B?
		O	*O*-OR	BlG	BG-GrB
		Y	Y	B	*V*-B
		YG	Y-OY	P	V
	25	O	O-OR	G	BG
	20	YG	YG	P	V-P
O=D	55	YG	Y	B	P-PR
	50	V	V-GrB...P	OY	GrY
	45	V	B-V	OY-O	YG
	40	P	P	YG-YeG	BlG
		O	O-OY	BlG	YeG
		OY	OY	GrB	YeG
	35	BG	BG	O	OR
		R	O-OY	BlG-G	GrB-BG
		YG	YG-GrY	P	V
	30	OY	OY	B	BG
		G	YeG	P-PR	B?
	25	B	GrB...BG	O	OR
		G	GrY-YG?	P	B?
	20	B	GrB...BG	OY	OR
		P	*P*-PR	YG-YeG	YG

TABLE XXI

White Background

	Fix'n.	Stim.	Sensation	A. I.	Change
O=D	80	Y	OY	B	GrB
	75	Y	Y-OY	B	GrB-BG
	65	YG	*OY*-Y	GrB	BG
		OY	O; OR	GrB	BG
	55	Y	OY	GrB	BG
		R	OR	B-GrB	GrB-BG
		YG	*Y*-OY	B	*GrB*-BG
		OY	*OY*-O	B	GrB

C. Frequency of After-Images

The observers show considerable variation in respect to the frequency with which colored after-images follow colored sensations. With R the occurrence is practically universal; with the black background, however, about five *per cent.* of his color sensations fail to be followed by colored after-images. The other observers show a slightly greater number of such failures. Inasmuch as the work with the black background was done almost entirely in the summer, under the best possible conditions of illumination, it seems evident that for our observers, at least, the black background is less favorable than the others to colored after-images. The grey background supplies the most favorable conditions, *i, e.,* gives the largest *per cent.* of colored after-images.

Inasmuch as our results (though they agree with those of Fernald) are, in this respect, at variance with those of Ferree and Rand, we give here the further support to our view obtained by the additional tests. We adopted a fixation-time of 2 (sometimes 3) seconds, and, keeping the procedure otherwise as before, required the observers to fixate the black ground either 5 or 10 seconds before exposure of the stimulus. The result showed some reduction in the saturation of the sensations, but always a correspondingly greater reduction in the after-images. We then, in addition, omitted all preparatory signals (on the assumption that this might possibly have been the Bryn Mawr procedure); the after-images suffered, however, as much as, if not more than, the sensations. In every case, the observers reported that the sensation was unquestionably and decidedly more saturated than the after-image. We then reduced the chroma of the stimulus by gradual addition of white, until the color passed below the limen. As before, the after-image was affected even more than the sensation, until the stimuli were so reduced that it became merely a matter of guessing for both sensation and after-image. We are forced, therefore, to hold to the belief that the black background is the least favorable for after-images.

D. Types of After-Images

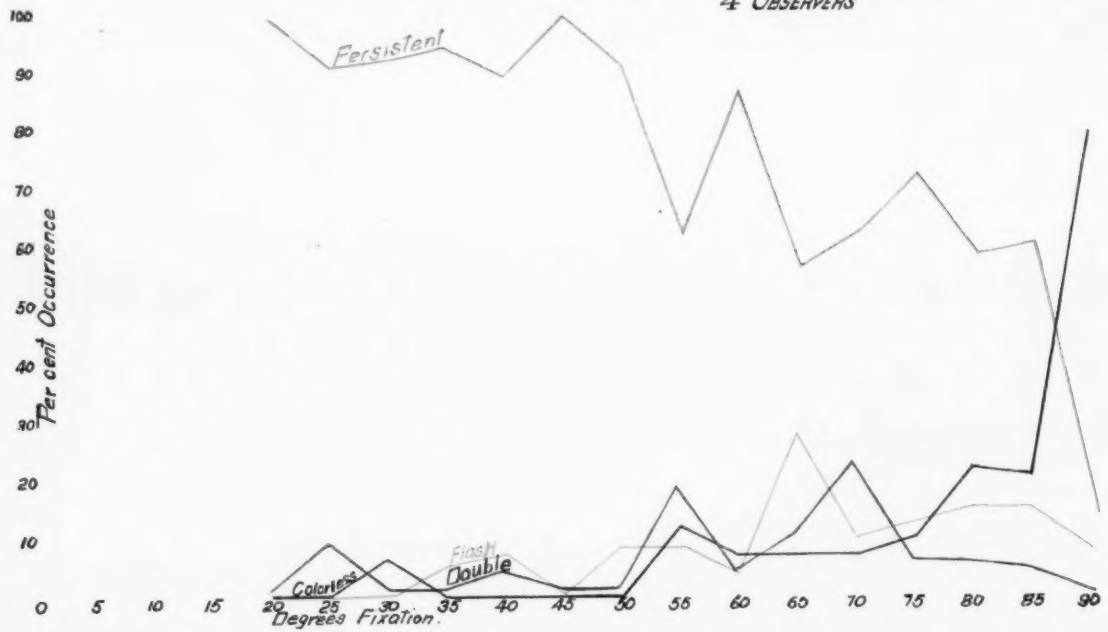
As with the sensations, the brightness of the background has a distinct influence on the duration of the after-images. It has been shown that there are two types of color sensation, designated as the "flash" and the "persistent" sensation, and that the "flash" type tends to occur at the more peripheral points, and most frequently with the white background, the

ground least favorable to color-sensations. In the case of the colored after-images we also find the two types, the flash-like and the persistent; and, in addition, a third type of occurrence which will be called that of " double " after-images. The double after-images are a succession of the flash and persistent types, occurring with a single stimulus. Figures 5-7 give a graphic representation of all types of after-images occurring with colored stimuli for each background (flash, persistent, double, and colorless). The values given are the estimated mean *per cents.* of occurrence for all observers. It will be seen that: (1) the flash-like after-images occur most frequently at fixation points of from 55-65 degrees; they are reported most often with the black background and least often with the white; (2) the persistent after-images occur most frequently with the grey background, slightly less often with the white ground, and least frequently with the black; they are most frequent at the fovea and least at the periphery; (3) the double after-images occur rarely except with the black background; here they attain an early maximum and then rapidly decrease; (4) the black ground gives the largest number of colorless after-images until a fixation of 65 degrees is reached; from that point on, the increasing number of colorless sensations with the white ground causes a coresponding increase in the number of colorless after-images reported. There is marked individual variation in the frequency of occurrence for the different types. D has the largest number of flash after-images; R, all of whose color sensations are persistent, reported no flash after-images. R and F reported almost no double images.

Flash after-images were experienced with all stimuli, but most often with those that were seen colored farthest out. The fact that they were experienced in a uniform way, most frequently, both as sensations and as after-images, with the least favorable backgrounds, seems to suggest that they are not the result of eye movement, as might at first be assumed. It seems more likely that they are in some way dependent on the movement of the projection screen across the field of the stimulus. They occur, subjectively, simultaneously with the perception of this movement. They occur, moreover, under conditions which are unfavorable to color experiences, that is, most often with the least favorable backgrounds and fixation points. They are experienced most often for the part of the visual field that is most sensitive to movement. It is, therefore, conceivable that the rapid but not instantaneous movement of the screen heightens in some way the otherwise subliminal value of the stimuli.

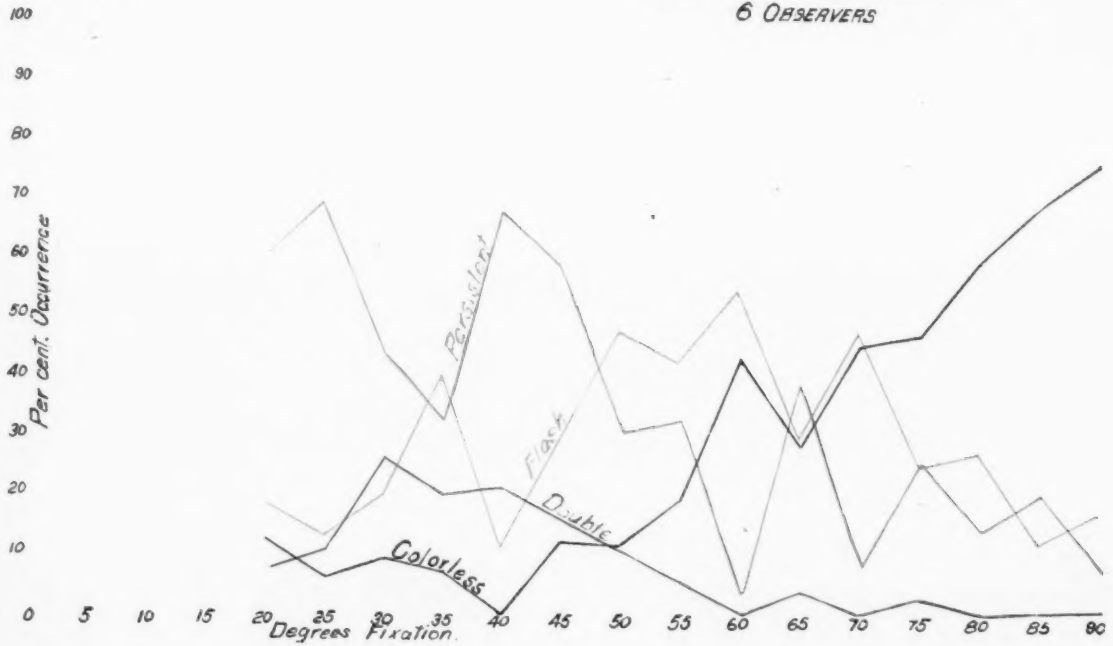
5

DISTRIBUTION OF TYPES OF AFTER IMAGES
BACKGROUND = PLATINUM GREY
4 OBSERVERS



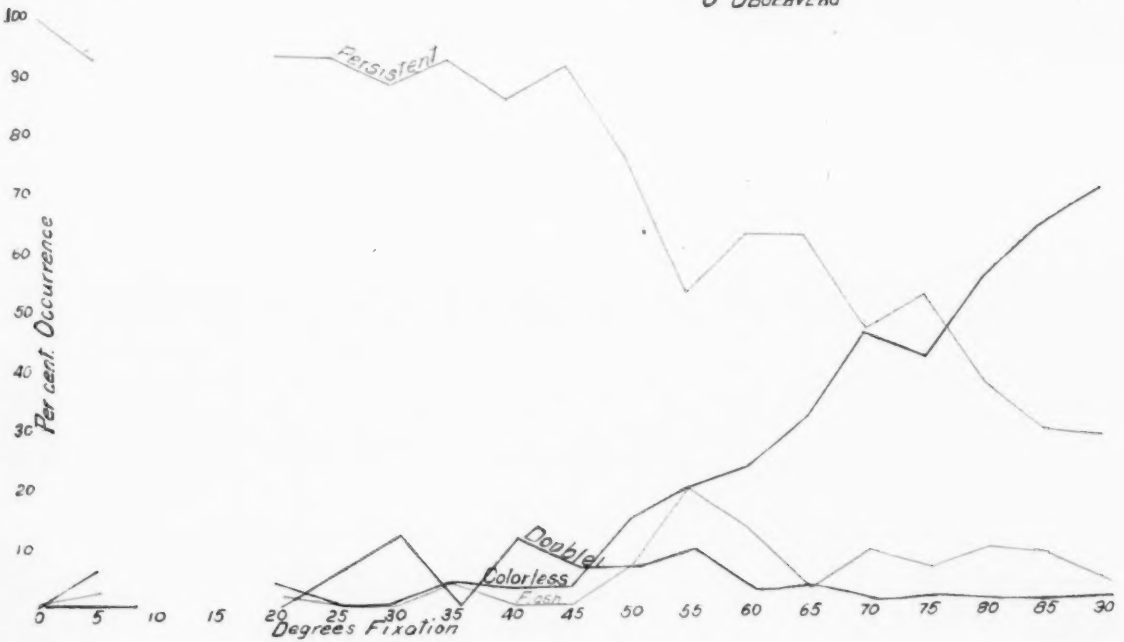
6.

DISTRIBUTION OF TYPES OF AFTER-IMAGES
BACKGROUND = HERING BLACK
6 OBSERVERS



7.

DISTRIBUTION OF TYPES OF AFTER-IMAGES
BACKGROUND = PLATINUM WHITE
5 OBSERVERS



III. Anomalous Results

A. General Classification

Along with the consistent and uniform results, there were reported a number of apparently anomalous occurrences. In this class we have included, perhaps too arbitrarily, such types of occurrence as: (1) colored sensations from colorless stimuli; (2) colored after-images from colorless stimuli; (3) colored after-images from colorless sensations; (4) other cases of anomalous hues reported with colored stimuli; and (5) all instances of colors seen during the fore-period of a given observation.

We will consider first those cases in which the anomalies occurred with colorless stimuli. These were reported with all backgrounds, on both bright and cloudy days, for all observers except Ge. With the grey ground 22%, with the black 6%, and with the white 9% of the total number of colorless stimuli gave colored sensations and after-images (these might or might not be complementary). The *per cents.* are 3, 15 and 12 respectively (for the three backgrounds), for reports of colored sensations and colorless after-images; and 3, 9, and 10 respectively, for reports of colorless sensations and colored after-images from these stimuli. We find, then, adding the *per cents.* for the three varieties, 28% anomalies with the grey ground, 30% with the black ground, and 31% with the white ground. There are, furthermore, a number of reports of color seen while the observer was resuming his fixation, or waiting for the stimulus to be exposed.

Greater in actual numbers, but smaller in *per cent.* of frequency, are the apparent anomalies with colored stimuli. These, also, occurred with all three backgrounds, with both good and poor illumination, and with all observers except Ge. Least conspicuous (because it is here difficult to say where normal variation stops and anomaly begins) are the cases where the hue of a sensation could definitely be called "queer." A number of instances were noted, however, where the sensation is distinctly "off color" for the given stimulus and background; where, for instance, the hue is one not normally seen at such eccentricity; and several others suggest that possibility. Much more frequent are cases where a colored stimulus is followed by a colorless sensation but a colored after-image. It was for these "colored after-images from subliminally colored stimuli" that we were especially on the look-out. We got them in greater numbers, perhaps, than Fernald, and certainly under more diverse conditions. They were reported, not only with

the white background under the full illumination, but with the other backgrounds, and with poor illumination, as well. The frequency was practically negligible with the black ground, but amounted, with the grey ground, to ½%, and with the white ground to 6% of the total number of tests. (Our recent tests with the black ground give added confirmation to these results): see p. 569. There were marked individual differences; the *per cent.* was highest for R and lowest for D and G. For no observer, however, was the percentage of frequency so high as in the cases where the "anomaly-inducer" was a brightness.

B. Possible Explanation

If these phenomena are not to be left in the class of anomalies, we must find some adequate and controllable cause for them in the conditions of the experiment. We must at least suggest a reasonable explanation.

1. Negative Evidence

We find ready a possible explanation for the numerous slight irregularities in the reports. The haphazard nature of the series as given, though an aid in eliminating expectation, is, evidently, not calculated for smoothness of results. The rapid change in hue during fixation, for the more peripheral points, introduces further irregularities. Suppose an observer's attention to be lagging at times; he may then easily misapprehend an intermediate stage in the transition of hue as the first hue seen and report it as such. Some of the colors, moreover, were experienced as such brief flashes that it was very difficult, as F put it, "to fix them." They must last a certain time, he said, in order to be labelled. In such cases, it is clear, a momentary lapse of attention might be fatal. There is, too, the additional difficulty that the poorer chromas are proportionately more difficult to "place" as to hue; it is obvious that a dark, poor green, for example, is much closer to yellow and blue, on the color pyramid, than is a saturated medium green.

Closely related to the difficulty of distinguishing hues, when the chroma is poor, is the difficulty of assigning names. The name "white" designates a brightness quality, that of "yellow" a color. If, in everyday experience, we have a luminous white, we may call it a "sunlight effect," and it is six of one and half a dozen of the other whether we mean to term it white or yellow. Many of the yellows and whites experienced with the white background were of this dubious sort. They were distinctly luminous, possibly as the result of the movement of

the white screen. D and G explicitly, and the other observers less so, found it difficult to make the decision, in such cases, as to color or brightness. G frequently reported, " It's white with a luminous effect " or " It's a sunlight effect." Sometimes she would decide that she ought to call it yellow, sometimes white, though she admitted that it was always the same. D, under the same stress, would make a decision at one time, and then, later, when the experience recurred, would decide that the earlier decision should be reversed. So the other observers would report " white," and often, after an interval, ask to have the record changed. Sometimes, to be sure, the change of opinion would be due to recollection of a forgotten experience; but usually it issued from a real doubt as to what to call the experience. Other experiences besides yellow gave difficulty in naming. B found it difficult, when the grey background was used, to distinguish the grey of the ground (if presented as a stimulus or used as a projection ground) from a blue-green of medium tint and extremely poor chroma. He repeatedly made this error in naming at times when there was no possibility of color adaptation. He afterwards admitted, on being questioned, that it was a common confusion for him. R and, to a less extent, F were apt to see the slightly darkened white of the projection ground, as they experienced it when somewhat adapted to it, or when it was darkened by the superposition of a colorless after-image, as a very light, poor violet or purple; they reported this experience even when all precautions were taken to secure achromatic adaptation.[10] F would sometimes say, " It's one of those cases where you'd be hanged if you know whether to report color or not." And R declared his judgments in such cases to be worthless. These hesitancies about naming make us doubtful of any reports in which they occurred.

It is evident, however, that such suggestions as are here offered would by themselves be scarcely convincing. But we find very definite evidence of the anomalous character of the reports so labelled, in the influence of the previous colored stimuli. In the cases where the hue reported is an " impossible " one, we find that it can be identified with the hue of the previous after-image. Thus, for example, F reports, with the

[10] This experience of purple or violet under apparently achromatic adaptation was provokingly frequent and insistent,—so much so that it seemed to be independent of external chromatic conditions. Prof. Titchener states that it gave trouble before in the work with the peripheral retina. Its recurrence in spite of all precautions seems to indicate that it is due to intra-ocular conditions.

grey ground, "yellow-green," when the stimulus was orange-yellow; we then find that the after-image of the preceding sensation lay between a yellow-green and a yellowish-green. Or, we have a grey reported as blue, and we find that the preceding after-image (or sensation) was blue. The reports of colored after-images with colorless sensations are to be classed, in this respect, with the reports of color with colorless stimuli. In practically all the cases (enough to make us sceptical as to the rest) we find evidence of the influence of the previous colored stimulus. It is perhaps, moreover, a significant fact that the large majority of such anomalous occurrences were reported at the beginning of the experimental hour.

2. Positive Evidence

Thus far our evidence has been mainly negative. We also sought for positive proofs. We selected influence of previous stimuli and variability of attention as controllable factors and tried (1) varying the direction of the attention and (2) varying the time-interval between tests, using in both cases the white background.

a. Change in the Direction of Attention

When the attention was on the stimulus rather than on the after-image, the number of colored after-images reported with colorless sensations was reduced, though some still occurred. When, on the other hand, the attention was directed to the after-image rather than to the sensation, the number of such anomalies was fully doubled. While these results are probably conditioned to some degree upon a central or 'subjective' factor, they are certainly due in large measure to the lapse of accommodation or the gross eye-movement which ordinarily accompanies relaxation of attention. As the method does not allow us to discriminate central and peripheral conditions, we must leave the facts in the rough, remarking only (1) that they should be borne in mind in any attempt to appraise Fernald's results, since she makes no reference to control of attention, and (2) that they are in agreement with previous results for B and R, when with the grey and white grounds respectively, under admitted unpleasant emotional distraction, the number of anomalous reports had been markedly increased.

b. Change of Interval between Tests

When the interval between tests was cut down to one minute or less, anomalies became the rule rather than the exception. An increase in the time-interval had the opposite effect. For B and F an interval of six minutes was sufficient to eliminate

them; R, who (as has been mentioned) was especially sensitive to color and adapted slowly, required, with the white ground, fully a ten-minute interval for complete achromatic adaptation; and even then he continued to report violet or purple with a white stimulus. Despite such occasional irregularities, the result of increasing the time-interval was so constant as to tell convincingly against the acceptance of these occurrences as normal.[11]

IV. Determination of Urfarben

While the work in determination of the *Urfarben* was yet in its early stages, it became evident that the present method was inadequate for exact results. The chief difficulty, aside from that of securing constant illumination, was the fact that a large number of fixation points were required. If these were much closer together than 5 degrees, steady fixation was difficult, and the results were correspondingly variable. We contented ourselves, therefore, with ascertaining that, even with adequate apparatus, the *Urfarben* would be constant only with the grey background; with the other backgrounds there is a uniform shift in a definite spectral direction. Fernald's statement that the *Urfarben* found with the grey ground hold for the black ground as well is probably due in part to the admitted hastiness of this part of her work; in part, also, to the fact (evident throughout her report) that she constantly neglected the smaller details and ignored slight changes in hue.

Conclusions

I. Critique of Method

As the result of our work with Fernald's method we are led to the following criticisms:

(1) It is an advantage, no doubt, to keep the eye stationary during the presentation of a stimulus. It is, however, a disadvantage to use a moving screen to cover the stimulus. For some observers it is a noticeable distraction; for all it may lead to a variation in conditions, since on the extreme periphery it may be more influential than nearer the center in heightening the effect of a weak stimulus.

[11] In the regular series, undertaken to test Fernald's conclusions, the anomalous after-images were, as we have said, likely to occur at the beginning of the experimental hour; not infrequently the very first observation yielded the anomalous result. In these test-series, with change of interval, a time of variable duration was allowed for preliminary achromatic adaptation; with sufficient time-allowance (up to about 10 min.) the initial anomaly disappeared.

(2) The apparatus is poorly adapted to fixations at less than 5-degree intervals from one another. For exact quantitative results it is, therefore, unreliable.

(3) The method may be improved by using, as we did, the Hering head-rest or some other like arrangement which provides for a constant position of the eye, for all fixation points, without thereby involving the slightest eye-strain.

(4) For satisfactory, reliable results, the interval between successive tests must be longer than two minutes. While this interval may be long enough for some observers, with the black background, it is certainly not enough with the white background. For highly sensitive observers, and the white background, nothing short of a 10-minute interval is adequate.

II. The Question of Anomalous After-Images

Inasmuch as it was one of the main objects of these experiments to investigate the occurrence of "colored after-images from subliminally colored stimuli," it may be well to give in some detail a summary of our conclusions.

(1) The frequency of these anomalous colored after-images was considerably less than that for like anomalies with colorless stimuli.

(2) Previous stimuli were found to influence the hue of succeeding sensations, as well as of succeeding after-images.

(3) Colors were seen during the fore-period of tests, after an interval of over two minutes.

(4) The number of anomalous after-images was increased when the attention to them was greater than to the corresponding sensation; the number was decreased when the attention was predominantly directed to the stimulus. We attribute this result, in the main, to changes of accommodation and to eye-movement.

(5) The frequency of their occurrence was increased as the interval between the tests was shortened, and was correspondingly decreased as the interval was increased. *An interval of ten minutes was found adequate, with the white background, for the most sensitive observer, to eliminate entirely such anomalies.* They had occurred in 6% of the observations of our regular series.

(6) Anomalous after-images occur, on the average for all observers, in only ½% of our regular observations with the grey background, and with negligible frequency when the black background was employed.

III. General Summary

A. The medium grey background gives us a standard account of the changes which color phenomena with the ten colored stimuli undergo, from the fovea to the periphery. We find that: (*a*) the sensations from: (1) red, orange, orange-yellow, yellow, yellow-green and green stimuli, shift toward or to yellow; while (2) blue-green, blue, violet, and purple stimuli, shift toward or to blue; and (*b*) the after-images from: (1) red, orange, orange-yellow, yellow, yellow-green, and green stimuli, shift toward or to blue; while (2) blue-green, blue, violet, and purple stimuli, shift toward or to yellow. The change in hue of the after-image is always such that the after-image is the complement of the sensation.

B. 1, Whenever the sensations or after-images are darkened, by (1) contrast with the white background, (2) the mixture of black with the stimuli, (3) the superposition of dark after-images on the sensations, (4) the projection of the after-images on a dark ground, or (5) the projection of after-images, already in course, on a light ground; then, always, there is a shift in hue in the direction of the red end of the spectrum.

2. Whenever the sensations or after-images are lightened by any of these five means, then, always, there is a shift in hue in the direction of the violet end of the spectrum.

C. Sensations and after-images have been found to change in hue during fixation. With the grey ground: (1) the sensations from orange, orange-yellow, yellow, yellow-green, green, and blue-green shift toward yellow; those from blue, violet, purple, and red shift toward red; (2) the after-images of red, orange, orange-yellow, yellow, and yellow-green shift toward green; those from green, blue-green, blue, violet, and purple shift toward green in the other direction. With the black ground, sensations and after-images from red, orange, orange-yellow, yellow, and yellow-green shift toward violet, those from green, blue-green, blue, violet and purple shift toward red, in comparison with those on the grey ground. The spectral direction is exactly the opposite with the white ground.

D. Different types of color sensation and after-image have been found. In the case of the sensation: (1) the 'flash" type occurs chiefly with the white ground at the more peripheral points; (2) the "persistent" type is found at all other points. As regards the after-images: (1) the "flash" type

occurs most frequently with the black background on the periphery; (2) the "persistent" type occurs most often with the white and grey grounds; (3) the "double" type, never frequent, is most often reported with the black ground; (4) colorless after-images are most frequent with the black background and least with the grey. It seems probable that the "persistent" type is the normal form for both sensation and after-image, and that the "flash" type, whether it occurs alone or as a member of the "double" type, is the result of the heightening of a liminal (or even subliminal) stimulus by movement of the screen across the field.

IV. Theoretical Discussion

Our results with the grey background are in agreement with the requirements of the Hering theory. The work with the black and white backgrounds, and with colors mixed with black or white as stimuli, indicate that: (1) the additional stimulation of the black process, with that for a given color, results always in a shift toward the red end of the spectrum; (2) the additional stimulation of the white process results in a shift toward the violet end of the spectrum; the amount of shift increases with an increase in the black-white process, until the color, already poor in chroma, becomes so dark or so light that it passes below the limen. Whether this result means that other color processes are actually stimulated, we cannot say. Nor can we say whether it means merely that certain brightnesses heighten the stimulating effect for certain colors, already physically present in the stimulus, at the expense of other colors also present. This question could be answered only by using physically pure stimuli, or those whose physical components were known. The problem presents no greater difficulties than does the mixture of black or white with colors seen at the fovea.

The shift in hue of sensations and after-images during fixation seems to indicate a greater instability of the peripheral retinal processes.

MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF VASSAR COLLEGE

XX. The Affective Values of Articulate Sounds

By Louise Roblee and M. F. Washburn

So far as we know, no attempt has ever been made to investigate experimentally the agreeable and disagreeable character of the sounds used in speech. It is obvious that apart from the associative power of words, the sounds which compose them may by their own pleasantness or unpleasantness exert a not inconsiderable influence on their literary value from an aesthetic point of view. Certain passages of poetry or prose are harsh or melodious in effect. It would seem a promising field in experimental aesthetics that is offered by the affective values belonging to articulate sounds.

The present study, of course, does not do more than effect an entrance into this field. The articulate sounds which we selected for study were combinations of an initial vowel and a final consonant. In order to get at the affective value of the sounds themselves, we chose from the syllables thus composed only nonsense syllables: had we used syllables with meaning, obviously the pleasantness or unpleasantness of the meanings would have wholly obscured that belonging to the sounds themselves. Of course we could not hope wholly to eliminate the meaning aspect, any more than is the case with memory experiments where nonsense syllables are used: a nonsense syllable is always likely to suggest something to the observer's mind. The *vowels* which we used were the following; a as in father, a as in fate, a as in hat, aw, e as in get, ee as in feed, i as in hit, i as in write, o as in hot, o as in wrote, oo as in boot, oi as in oil, u as in mud. The *consonants* were: *checks*, the hard labial p, the soft labial b, the hard dental t, the soft dental d, the hard guttural k, the soft guttural g; *breaths*, s, z, f, v, sh, zh, th; the *nasals*, m and n; *trills*, l. The list of syllables was made by combining each vowel as initial sound with each consonant as final sound, and then eliminating all the combinations that had meaning. The syllables thus chosen were pronounced in a fixed order, constant for all the observers, care being taken to use the same pitch and intensity of voice throughout. As the same person served as experimenter during the entire research, the conditions of pitch and timbre of voice were as constant as it is possible to make them. The order was such that the same sounds did not occur in successive syllables. The observer was asked on hearing a syllable to express her judgment as to its pleasantness or unpleasantness by using one of the numbers 1 to 7 in the usual way. The factor of affective contrast was of course present: if a given syllable was immediately preceded by a very pleasant or a very unpleasant one, its affective value would naturally be influenced in the opposite direction. Using a constant order for the syllables tended to make this factor constant for the different observers, but did not eliminate it: to do the latter would require a very long interval between successive syllables, which in turn would involve not only delay but also

variations in the condition of the observers and serious sources of error.

There were fifteen observers, all women, most of them untrained in introspection. Thirteen of them performed the entire experiment twice, at considerable intervals of time, affording an opportunity, as will be seen, for a study of the consistency of judgments made at different times on the same material.

The affective value of each vowel and each consonant was calculated by finding the average of the affective values assigned by all the observers to all the syllables in which the vowel or the consonant occurred. For the thirteen observers who performed the experiment twice, the averages were calculated separately for the first and second trials. The results thus obtained may be stated very briefly.

Vowels. The least agreeable vowel of those investigated is u as in mud, its average affective value for fifteen observers on the first trial being 2.9, mean variation .33; for thirteen observers on the second trial, 2.9, m. v. .34. Next above this stands the sound oi, with an average value of 3.4 on the first trial, m. v. .89; and of 3.3 on the second trial, m. v. .95. The very large mean variations here indicate the fact that the observers were less agreed as to the pleasantness and unpleasantness of this sound than as to that of any of the other vowels. Third came the sounds aw, whose average value on the first trial was 3.6, m. v. .49, and on the second trial 3.5, m. v. .40; o as in hot, whose average value on the first trial was 3.5, m. v. .28, and on the second trial 3.6, m. v. .36; and ee, whose average value on the first trial was 3.5, m. v. .46, and on the second trial 3.6, m. v. .51. Fourth came oo, with an average affective value on the first trial of 3.7, m. v. .4, and on the second trial of 3.5, m. v. .3; and i as in hid, with an average value of 3.6, m. v. .42, on the first trial, and of 3.6, m. v. .47, on the second trial. Tied for fifth place were a as in hat, with an average value of 3.8, m v. .41, on the first trial, and of 3.8, m. v. .33, on the second trial; and i as in write, with an average value of 3.7, m. v. .41, on the first trial, and of 3.9, m. v. .53, on the second trial. Sixth stood a as in fate, whose average value for the first trial was 3.9, m. v. .68, in the second trial 3.9, m. v. .54. The next higher was o as in wrote, with an average value of 4.1, m. v. .32, in the first trial, and of 3.9, m. v. .17, in the second. Next to the highest in affective value was e as in get, whose average value for the first trial was 4.2, m. v. .36, and for the second trial 4.1, m. v. .36. And the most agreeable of all the vowels was a as in father, with an average value of 4.3, m. v. .53, on the first trial, and of 4.3, m. v. .43, on the second trial.

A better indication of the individual affective tendencies than is given by the mean variations of these averages may be found in the following statements. There were six out of the fifteen observers who found the vowel a as in father the pleasantest; five who found the vowel e as in get the pleasantest, three who found the vowel a as in fate the pleasantest, and one each who found o as in wrote and oi the most agreeable. There were eight observers who judged u as in mud the most disagreeable vowel, five who found oi the most disagreeable, two each who judged the most unpleasant vowel to be ee, aw, and a as in fate, and one who judged oo the most disagreeable. The fact that a as in fate and oi were by some observers held to be the most disagreeable and by others the most agreeable vowels is reflected in the large mean variations of their averages.

These averages are computed by averaging the averages of the

various judgments made by each observer on all the syllables containing the vowel in question. Evidently one and the same average furnished by a single observer may represent either a fairly constant judgment on all the syllables with the given vowel, or extreme judgments of an opposite and compensating character: in other words, our averages, while their own mean variations are given, have nothing to show the variations from the averages of which they are composed, and therefore may be very misleading as representatives of the preferences of our observers for different vowels. It seemed best for this reason to calculate the percentages of judgments of a high degree of pleasantness and unpleasantness for each vowel, that is, the percentages of judgments of 6 and 7 on the one hand and of 1 and 2 on the other. The order of diminishing pleasantness, beginning with the vowel which had the highest percentages of 6 and 7 judgments, was as follows: a as in father, e as in get, oo and a as in fate, o as in wrote, oi, i as in write, a as in hat, ee, i as in hit, o as in hot, aw, u as in mud. The order of diminishing unpleasantness, beginning with the vowel which gave the largest percentage of 1 and 2 judgments, was: u as in mud, oi, ee, oo, i as in hit and aw, o as in hot, i as in write, a as in hat, a as in fate, o as in wrote, a as in father and e as in get (same percentage). Oo seems to be a vowel which is the source sometimes of decided pleasantness and sometimes of decided unpleasantness, judging from its high position on both lists; the same is true of oi. I as in write, and a as in hat, on the other hand, are neutral vowels, seldom giving rise to extreme judgments of either sort.

Consonants. The most disagreeable final consonant, according to the averages, is g, average value on the first trials 2.4, m. v. .4; on the second trials, 2.3, m. v. .37. K comes next, its average value being 2.6, m. v. .4, on the first trials, and 2.5, m. v. .38, on the second trials. Next came sh, value 3.2, m. v. .87, on the first trials, and 3.1, m. v. .7, on the second trials; and t, value 3.2, m. v. .4, on the first trials, and 3.1, m. v. .4, on the second. The order of the rest was as follows: zh, first value 3.8, m. v. .79, second value 3.3, m. v. .66; b, first value 3.7, m. v. .4, second value 3.7, m. v. .4; d, first value 3.7, m. v. .5, second value 3.8, m. v. .37; f, first value 3.7, m. v. .48, second value 3.8, m. v. .37; p, first value 3.7, m. v. .39, second value 3.8, m. v. .34; z, first value 3.9, m. v. .67, second value 3.6, m. v. .57; s, first value 3.9, m. v. .5, second value 3.7, m. v. .32; th as in breath, first value 3.9, m. v. .57, second value 3.9, m. v. .51; th as in breathe, first value 4.1, m. v. .6, second value 4.1, m. v. .6; v, first value 4.2, m. v. .56, second value 4.1, m. v. .48; n, first value 4.3, m. v. .5, second value 4.5, m. v. .3; m, first value 4.6, m. v. .48, second value 4.3, m. v. .4; l, first value 4.8, m. v. .5, second value 4.8, m. v. .4.

Checking these results as we did for the vowels, we find that there were ten observers who found l the most agreeable of final consonants, three who found m the most agreeable, three who found n the most agreeable, and one each who preferred th as in breathe, s, and zh to all others. There were nine who thought g the most disagreeable final consonant, three who disliked sh more than any of the others, two each who found k and zh the most unpleasant, and one who disliked t most of all. When the percentages of 6 and 7 judgments and of 1 and 2 judgments were calculated, the order of diminishing pleasantness was as follows: l, m, n, th as in breathe, v, zh, th as in breath, d, z, s, p, sh, f, b, t, k, g. The order of diminishing unpleasantness was: g, k, t, zh, d, p, z, b, s, th as in breath, f, th as

in breathe, v, m, n, l. Zh seems to be a consonant which is sometimes decidedly pleasant and sometimes decidedly unpleasant; s and f are rather neutral, not furnishing a high percentage either of very pleasant or very unpleasant affective values.

A possible source of error in our method lay in the fact that each vowel was not used in combination with all the consonants in turn, for all combinations that had meaning were eliminated. Thus b, for instance, could be used as a final consonant with more vowels than t could, because fewer of its combinations made sense. Now it might happen that a particular vowel could be used only in connection with a group of consonants that happened to be pleasant ones, while the consonants used with another vowel, because they made meaningless combinations with it, might be particularly disagreeable ones. To investigate this influence, the average affective values were calculated of the vowels used with each consonant, and of the consonants used with each vowel. The average value of the consonants used was 3.6 in the case of all the vowels but two; for e as in get it was 3.7, and for aw it was 3.5. The former was therefore slightly helped by the fact that it was used with rather more agreeable consonants, while aw lost a little through the influence of its associated consonants. The effect of the consonants must, however, have been very slight, and by no means enough to account for the positions of these vowels in the series of affective values. The average value of the vowels used was 3.6 for all the consonants except the following: l, p, and v, 3.7; d, 3.5, t, 3.4. Thus l, the most agreeable consonant, was somewhat helped by its vowels, and t would undoubtedly have had a higher place had it been associated with pleasanter vowels. On the whole, however, the fact that the associated letters differed for different vowels and consonants seems to have had no important influence on their affective values.

A curious uniformity is apparent when the mean variations for the first series of trials are compared with those for the second series of trials. There were seventeen consonants used, and in the case of none of these is the mean variation for the second series of trials larger than that for the first series. In the case of fourteen, the second-series mean variation is smaller than the first-series mean variation: in the other three cases both mean variations have the same value. It seems hardly possible that such uniformity can be without significance and due to accident. A possible explanation for it would be to suppose that associations played a greater part in the first set of tests made by each observer, and that as associations differ for different people, there was less agreement among the individual observers in the first series. In the later tests, it may be argued, practice enabled the observers to base their judgments on the affective character of the sounds themselves, regarding which there is, we should have to conclude, a greater degree of unanimity among different persons. The mean variations for the vowels do not show the same tendency. May it perhaps be true that associations are more persistent in their influence on the affective character of vowel sounds? We have not the data on which to base a positive conclusion with regard to this matter.

The Self-Consistency of the Observers. A chapter in experimental aesthetics should deal with the self-agreement of an observer in judging the pleasantness or unpleasantness of given material at different times. Of course the causes of variation are often to be found in conditions such as the physical state of the observer or accidental

reasons for high or low spirits on his part, but other factors might be investigated whose laws could be more easily ascertained. For instance, in using our method, it may be asked what kind of judgments an observer is least likely to change at a second experience: if a syllable has been assigned an extreme affective value, 7 or 1, at the first trial, will this judgment be more or less subject to revision than if it had been assigned a moderate affective value, 3 or 5, or had been a judgment of indifference, 4? Are we more likely to change our minds with regard to our extreme likes and dislikes or with regard to our moderate ones?

To investigate this point, we first counted the number of judgments of each kind (1, 2, 3, 4, 5, 6, and 7) made by each observer, and then, counting the number of these judgments which were unaltered in the second series of experiments made by the corresponding observer, we calculated the percentages. It is essential to note that the observers never reported remembering their previous judgment on a syllable, and the syllables were so numerous that such recollection would not be likely to occur often. The number of judgments of 1 and 7 was so small that the percentages calculated for them are not trustworthy. But the results showed quite plainly that the degree of constancy was greater for the judgments of a slight degree of pleasantness or unpleasantness (3 or 5) than for the judgments of a fairly high degree (2 or 6). It would seem that, under these experimental conditions, when we have asserted a considerable degree of affective reaction to an impression, we are more likely to change our minds at a later trial than when we have asserted only a moderate degree. With regard to the judgment of indifference, 4, the case is somewhat peculiar. Some observers rarely make it, and indeed the *Aufgabe* of the experiment, which demands of the observer an affective reaction, works against the occurrence of this judgment. Observers of this type, who make sparing use of the judgment 4, have a strong tendency to change it on the second trial. On the other hand, if an observer has no hesitation in pronouncing a syllable indifferent on the first trial, she has a strong tendency to make the same judgment at the second trial.

Summary. The most agreeable vowels in combination with a final consonant are a as in father and e as in get; the most disagreeable is u as in mud. The most agreeable final consonants are l and the nasals m and n; the most disagreeable are the gutturals g and k. There is most disagreement among the observers with regard to the affective value of a as in fate, oi, and oo, among the vowels: zh is the consonant with regard to which there is least unanimity. The vowels i as in write, and a as in hat, and the consonants s and f, are neutral, seldom occasioning judgments of extreme pleasantness or unpleasantness. In the case of the consonants, the thirteen observers who were tested twice showed more unanimity in the second trials than in the first ones: a possible explanation would lie in the falling off of associative influences with practice. If this explanation is true, the vowels must preserve their associations longer than the consonants, for no increase in unanimity is observable in their averages between the first and second trials. The observers changed their minds on a second trial less in regard to the moderate judgments 3 and 5 than in regard to the more extreme judgments 2 and 6. Observers who readily used the indifferent judgment 4 tended to abide by it: those who used it sparingly tended to change it at a second trial.

BOOK REVIEWS

The Mafulu Mountain People of British New Guinea. By R. W. WILLIAMSON. With an Introduction by A. C. Haddon. London, Macmillan & Co., 1912. pp. xxiii, 364.

Readers of Dr. Seligmann's great work will remember the statement that "the mountains inland of Mekeo, Nara and Kabadi are inhabited by a number of tribes of whom our knowledge is extremely limited." Mr. Williamson, by his investigation of the Mafulu people, has now made a very valuable addition to that knowledge. The Mafulu inhabit a number of villages in the mountainous hinterland of the Mekeo district,—almost due east of Cape Possession, and almost cut by a line drawn from the north end of Yule Island to Mt. Albert Edward. They have had but the slightest contact with Europeans: practically none, indeed, before the establishment of the Catholic Mission five years previous to Mr. Williamson's visit. They therefore offered an admirable field for ethnological study. Mr. Williamson had the ungrudging assistance of the Mission Fathers, and has collected a great deal of information. Much more, of course, remains to be done; while the peoples living still further back in the mountains, the Ambo and Boboi and Oru Lopiku, yet await their investigator.

The rules of ethnographical enquiry have now been fairly standardised, and the present work might serve as a paradigm of accepted methods. But Mr. Williamson was fortunate enough to make a real discovery. He has "shown strong evidence that the Mafulu and probably other adjacent mountain tribes are essentially a pygmy—that is to say a Negrito—people who have been modified to some extent by Papuan and possibly Papuo-Melanesian influence, both physical and cultural" (Haddon); and he believes "that the negrito element is derived from an original ancestry who were probably the earlier inhabitants of New Guinea." The discovery is confirmed by the results of the expedition sent out by the British Ornithological Union to Dutch New Guinea in 1909, which was on the ground at the same time as Mr. Williamson; we learn in Mr. Wollaston's recent book on *Pygmies and Papuans: the Stone Age To-day in Dutch New Guinea* of a west-end pygmy stock, the Tapiro, which is evidently less mixed than Mr. Williamson's Mafulu. Ethnologists had, of course, had their suspicions; but our author raises presumption to practical certainty; and he well deserved his good fortune, since—as Dr. Haddon tells us—"he was unwell during the whole of his time in New Guinea and had an injured foot and leg that hurt him every step he took."

For the rest, the book will go on our shelves as a mine of comparative detail. Mr. Williamson gives an excellent account of the structure of the village club-houses or *emone*, and of the most important function of a community of villages, the Big Feast, which he regards, in origin, as a ceremony for finally 'laying the ghosts' of the chiefs whose bones are dipped in the blood of the slain pigs. He thinks that music "is usually more indigenous in hill country than it is in the plains," and finds that the Mafulu are correspondingly more musical than the Mekeo; they have the drum, a jew's-harp, and a small flute,—the latter probably borrowed from the Mekeo. There is no sign of

totemism: "I was unable to discover the faintest trace of any idea which might be regarded as being totemistic, or having a totemistic origin." This fact, interesting in itself, is rendered the more interesting by the parallel observation that "art and design among the Mafulu people are only of a simple and primitive type." As one passes from coast and plains to the hills, there is "a sudden drop from artistic designs embodying curves and natural imitative art to a system confined to straight lines, zigzags, and spots:" this in spite of a "contact which has certainly existed for some time back." The author concludes, reasonably enough, that the lack of imitative art "is partly due to the absence of totemism and of the imitative stimulus which, as Dr. Haddon has more than once pointed out, arises from it."

The volume is well illustrated by 91 photographic plates and 10 figures in the text; there is also a good map. There are five linguistic appendices by Messrs. Ray and Strong, largely based on the work of the Rev. Father Egedi and the Rev. E. P. Money. E. B. T.

The Gateways of Knowledge: an Introduction to the Study of the senses. By J. A. DELL. Cambridge, The University Press; New York, G. P. Putnam's Sons. 1912. pp. xii, 171. Price $1.50.

This little book contains a number of elementary exercises in experimental psychology, with parallel reference to anatomy and physiology. After an introduction dealing with the Meaning of Observation, the following topics are discussed: the Brain, Nerves and Organs of Sense; the Cutaneous Senses; the Machinery and Experience of Movement; Taste and Smell; Sound and Hearing; Light, the Eye, and Sight; Action; and Memory. The work is intended for pupils of about 12 to 15 years of age, and the experiments and materials are much simpler than those, *e. g.*, of Seashore's *Elementary Experiments in Psychology*. The author is plainly an enthusiast for his subject; he writes with clearness, and yet without shirking difficulties of subject-matter and of method; and some of his devices, as well as some of the additional exercises appended to the various chapters, are most ingenious. It should be said, however, that there are additional exercises which call for more knowledge than is imparted in the text.

The book is, I believe, the first of its kind; it marks a new departure in Great Britain; and it will, no doubt, pass through a number of editions. For these reasons I think it worth while to offer suggestions and criticisms in some little detail.

The author rightly distinguishes the questions "How does the sense-organ work?" and "What does it feel like to see (hear, taste, etc.)?" Yet his psychological exercises rarely take the form 'what does it feel like;' for the most part they give answers to the questions "How delicately or accurately can we feel?" and "What information regarding the outside world do we get by seeing, etc.?" Here is a confusion (witnessed by the 'sensations of heaviness, whiteness' and the like on page 2, and by the 'two sensations' received from a pair of gloves on page 22) which, one would suppose, an intelligent pupil must remark, and which also detracts from the scientific value of the work; a standpoint, once chosen, should be adhered to. Passing to special points, I suggest that needles might be replaced by bristles in the aesthesiometric experiment. Short hog's bristles, with points rounded by burning, serve the purpose; the same bristles may be used for the detection of pressure spots,—which the author does not mention, though he refers to cold and warmth (erroneously called heat) spots. The silk threads of the touch-weights should be fixed by sealing-wax to

the ends of matches; the use of the bare silk is inconvenient. I doubt whether warmth spots can be found by the method given (p. 34). The sensation of pain should not be confused with unpleasant feeling. On page 39 text and figure are not in agreement; the figure on page 45 has no letter D; the figure on page 96 needs further explanation, since the retina appears to be continued into the zonule of Zinn. On pages 58-9 there is a confusion of letter and packet. On page 60 Weber's Law appears without explanation as the Weber-Fechner Law (see pp. 29 f.). On page 63 there is confusion of adaptation with fatigue; and the night-blindness of the fovea is ignored. It is not correct to say that the internal ear "consists of cavities in the ear bone." The English of Hörmesser is acoumeter. On page 83, 1906 should be 1905. The neglect of contrast and adaptation on pages 108 f. is remarkable. The phrase "unconscious use of the imagination" (p. 126) is not scientific. On page 131 'several times' should be 'twice.' The reference to Sanford on page 135 will mislead the pupil; the method goes back to Helmholtz and Aubert. The norm of 0.27 sec. on page 150 is seriously misleading. The graph on page 153 omits three determinations, and the 40 per cent. is evidently a mistake.

These are small matters, which the author, if he will, can readily change. I suggest, further, that a qualitative aesthesiometric experiment be introduced, in which the observer is not confined to the judgments 1 and 2; and that experiments on visual contrast and adaptation be added. There is much cheap apparatus of which the author is apparently unaware. Thus Nagel's cards serve excellently for the diagnosis of color-blindness; it is unnecessary to pay $30 for the Edridge Green lantern. The spectrum-chart saves the expense of a spectroscope. I assume that the whirling-table is to be borrowed from the Physical Laboratory; but borrowing and lending are ticklish things; and Mr. Dell will find that a mechanical mixer of the Hering type can be built very cheaply from odd wheels to be picked up at any machine-shop. The mixer will then serve for a number of experiments, and will replace the whirling string of ex. 72. Nendel has some cheap materials for visual sensation; my own adaptation frame (*Text-book*, p. 73) may be made at home for next to nothing; and an admirable demonstration of contrast may be given with black, white and grey papers, mounted on a folding card like a Japanese screen. I understand that Münsterberg's Pseudoptics is, unfortunately, off the market; many interesting optical illusions may, however, be shown by means of black and white cards and paper-fasteners. Galton's weights may be copied by weighted pay-envelopes or cartridge-cases. E. B. T.

Modern Science and the Illusions of Professor Bergson. By H. S. R. Elliot. With a preface by Sir Ray Lankester. New York and London, Longmans Green & Co., 1912. pp. xix, 257. Price $1.60 net.

This little book contains a spirited, not to say a violent attack upon the philosophical teaching of M. Bergson. An Introduction points out the futility and incomprehensibility of all metaphysics, and represents Bergson as attempting a mediation between mechanism and teleology. Ch. II sets forth the leading doctrines of the *Creative Evolution* and the *Matter and Memory*. Ch. III gives the author's reasons for dissent. Bergson is guilty of three fallacies: he thinks that disproof of rival theories is proof of his own; he is addicted to false analogies; he makes deductions from questionable premises. He is chargeable, further, with hopeless and irremediable misuse of language. In par-

ticular he fails to show (1) that time is a stuff both 'resistant and substantial;' (2) that consciousness is to some extent independent of cerebral structure; and (3) that instinct leads us to a comprehension of life which intellect could never give. Ch. IV reviews the progress of philosophy, with the help of Lewes and Lange; traces the gradual growth of the mechanistic theory of the universe; and decides that philosophy fails in its search for final truth. Ch. V upholds the automaton theory as against McDougall. Ch. VI traces the origin of fallacies to primitive and congenital tendencies to believe, tendencies which weaken with evolution, so that the fully developed brain of man approaches an impartial *tabula rasa*. Ch. VII defines the true province of philosophy as increase of positive knowledge (this is, however, more correctly referred to science) and dissipation of error, the break-up of erroneous intuitions about conduct.

It is, perhaps, needless to say that the author is tarred with his own critical brush. He will hear nothing of metaphysics, yet he formulates a metaphysical attitude (p. 229 and elsewhere); he will hear nothing of epistemology, yet he commits himself to a theory of knowledge (p. 220 and elsewhere). But with all his constructive weakness there can be no doubt that his criticism is in large measure effective; and his outspoken protest against Bergsonian mysticism is wholesome. Many of us feel, with the writer of the preface, that "M. Bergson is gifted with an admirable facility of diction, and has succeeded in arresting attention. On that account, since he has exceeded the limits of fantastic speculation which is is customary to tolerate on the stage of metaphysics, and has carried his methods into the arena of sober science, it is a matter of urgency that his illusions and perversions should be exposed with uncompromising frankness." The book will probably make for good; but the last word must be left to the philosophers von Fack.

A Manual of Mental Science. By L. M. Wuirra. New York, Metaphysical Publishing Co., 1911. pp. 221. Price $1.

This little book has a practical as well as a theoretical side. For "Exact Thinking renders Mental Healing possible, sure and safe." Let us, then, begin to think exactly. We come upon such verities as that Truth contains no error; that Of two contradictory opposites or statements both cannot in any event be true; that Something from Nothing is impossible—nay, more, that Something cannot be produced from nothing; that the Substance of Nothing is vacancy. Continuing our efforts, we discover that Man is spiritual in essence but mental in action; that there is no Source of evil or disease; for disease proceeds only from incorrect thinking, and its cause is always mental; so that the Mentality is the only Source of sickness. On the basis of such Exact Thinking, the author formulates Rules for Living, for Character, for the Home, for Business and for Health.

Across Australia. By Baldwin Spencer and F. J. Gillen. In two volumes. London, Macmillan & Co., Ltd.; New York, The Macmillan Co. With illustrations, maps and plates. 1912. Vol. I., pp. xiv., 254; vol. II., pp. xviii., 255-515. Price $7 net.

Messrs. Spencer and Gillen are the joint authors of two very valuable works upon the ethnology of Central Australia,—*The Native Tribes of Central Australia* (1899) and *The Northern Tribes of Central Australia* (1904); the former book has, unfortunately, been

allowed to go out of print. The volumes now before us record no new investigations; they recount, in more or less popular form, a traverse of the continent from Oodnadatta in the south to the Gulf of Carpentaria in the north, and thus generalize and condense the travels and labors of the authors upon several separate journeys. Geographical features, climate, fauna and flora, are set forth in vivid and entertaining fashion; and the reader's interest is held by such incidents as the discovery of a true crab on the dry steppes or of a Central Australian honey-ant like that of Colorado and Mexico, by the description of a palaeolithic feast (129 ff.), by tales of early exploration and settlement, and by good-humored stories of the accidents and discomforts of camp life. The social organization, customs, beliefs and ceremonial observances of the various tribes—from the Urabunna through the celebrated Arunta, the Kaitish, Unmatjera, Warramunga, Tjingilli, Umbaia and Binbinga, to the coastal Anula and Mara—are explained with sympathy and understanding, though, as is natural in a popular work, a multitude of details and many cardinal points, familiar to readers of the more technical works, have been omitted. The book as a whole offers an admirable introduction to the ethnology of Central Australia; it gives the earlier volumes a background and perspective whose absence, realized but dimly when they were first read, can now be seen to have been a serious deficiency. It shows, more especially, how the writers obtained their information and their photographs: both of them were considered as fully initiated members of the Arunta tribe, and were known familiarly to their fellow-tribesmen as "stomach" and "little stomach"—we learn that on one occasion their respective capacities were thirteen and six eggs at a meal; both were therefore allowed and even invited to be present at the most sacred ceremonies; and the natives were everywhere friendly,—the Tjingilli, for instance, actually sending messengers on ahead, without saying anything about it, to tell the Umbaia that the visitors were coming and were to be well treated.

The two volumes are lavishly illustrated, though (unless I am mistaken) all the cuts, with the exception of some views of scenery, have been published elewhere. There are a few signs of haste, or perhaps of the dual authorship, as in the repetition of the note on porcupine grass (110, 145; there are other similar repetitions) and in the discrepancy of the dimensions assigned to Ayers Rock (111, 113 f.). In general, however, the writing is as careful as it is interesting, and the work may be cordially recommended.[1] E. B. T.

The Life of Nietzsche. By ELIZABETH FOERSTER-NIETZSCHE. Vol. I. The Young Nietzsche. New York, Sturgis and Walton Co., 1912. pp. xi, 399. Price $4.

This, the first volume of a popular biography of Nietzsche, covers the happy years from 1844 to 1876; the second and concluding volume will show us the other, *The Lonely Nietzsche.* We read here of Nietzsche's childhood: he lost his father when five years old, and was brought up in a feminine household, with grandmother, mother, two aunts and his only sister. We read further of his school days at Pforta, with their scrapes and successes; of his year at Bonn, and

[1] Since this notice was written, anthropology has suffered a serious loss by the death of Mr. F. J. Gillen. It seems strange that while Professor Spencer received the well-earned honor of a C. M. G., Mr. Gillen—a special magistrate and sub-protector of aborigines, and precisely the type of official that one would suppose the imperial authorities desirous to encourage—should have gone unrewarded.

the unhappy membership in the *Franconia;* of his following of Ritschl to Leipzig, where he spent two pleasant and profitable years, busy with Schopenhauer, music and the Philological Club, and where he met Wagner for the first time; of the year's soldiering and the unfortunate accident that marked it; and of the unexpected call to Bâle as assistant professor of classical philology. Nietzsche entered on his university duties in 1869, and was promoted to a full professorship in 1870; he saw much of the Wagners at Tribschen; and everything was going well when the war broke out. A naturalised Swiss subject, Nietzsche nevertheless volunteered his services to his fatherland, and was accepted as an ambulance nurse; after a few weeks in the field he was stricken with serious illness, which permanently undermined his health. Returning to Bâle, he published the *Birth of Tragedy* (end of 1871). The rest of the tale is taken up with ill-health, due to eye-strain, and with journeys made in the hope of restoration; with the life at Bâle in company with his sister; with the abortive essay toward marriage; with the publication of the four tracts *Thoughts out of Season;* and with the final visit to Bayreuth and the culmination of the revolt from Wagner. Nietzsche has now bidden farewell to his two youthful ideals, Schopenhauer and Wagner, "and must walk unaccompanied along the hard solitary road of his manhood."

The book is interestingly written; and though the present reviewer faced the large octavo volume of 400 pages with some misgivings, he has read it through with enjoyment. A dozen photographic illustrations add to its value.

Introductory Philosophy: a Text-book for Colleges and High Schools. By C. A. DUBRAY. New York, Longmans Green & Co., 1912. pp. xxi, 624.

Within the compass of 600 octavo pages the author gives us a General Introduction (on the nature of philosophy and on the general view to be taken of the world and of man), an empirical psychology, a logic, an aesthetics, an ethics, an epistemology, a cosmology, a rational psychology, a theodicy, an outline of the history of philosophy, and a General Conclusion (on the universe, on man, and on God). The book is written from a consistent point of view, and with an experienced teacher behind it may serve as a work of systematic reference. As a text-book it hardly commends itself; the style is arid, and the connection of paragraphs, as is natural from the brevity of the exposition, is by no means always clear. To the present reviewer the work seems totally unfitted for high-school use. And college students would probably learn more from introductory courses in psychology, logic and ethics, followed in later years by separate courses in the less empirical disciplines and in the history of thought, than from such a compendium as Dr. Dubray has here provided.

BOOK NOTES

The realm of ends, or pluralism and theism. By JAMES WARD. New York, G. P. Putnam's Sons, 1911. 490 p.

The chief chapters are: the one and the many, pluralism, its difficulties. This constitutes the first part, headed pluralism. The second, headed theism, treats of the idea of creation, cosmology, theism, freedom, its relations to foreknowledge, the problem of evil and pessimism and optimism, moral evil and moral order, thoughts of a future life, faith and knowledge, realm of ends.

A system of psychology. By KNIGHT DUNLAP. New York, Charles Scribner's Sons, 1912. 368 p.

For a text-book, this is a vigorous, interesting and ingenious presentation of the topics which lie within its scope. After a preliminary analysis of content, the author treats of sensation in general, its quality, thresholds, sensation intensity, protensity and extensity of sensation, local significance, relational elements in the content of consciousness, ideas as elements of content, retention, memory and recall, association, perception, affective content or feeling, action and will, self or empirical ego, degrees of consciousness, its time relations, the subconscious, the ego, the occult.

An introduction to psychology. By WILHELM WUNDT. Translated from the second German edition by Rudolf Pintner. London, George Allen & Co., Ltd., 1912. 198 p.

This is a shorter and slighter sketch than the same author's outlines and it has had enormous popularity in Germany. There are only five chapters treating of consciousness and attention, the elements of consciousness, association, apperception, and the laws of the psychic life.

Neue Lehre vom zentralen Nervensystem. Von EM. RÁDL. Leipzig, Wilhelm Engelmann, 1912. 496 p.

After discussing the difference between the old and new neurology, the author enters upon a consideration of the eyes of animals, then of the nervous centers in general, types of visual centers, the asymmetry of these optical centers, cascade fibres, invertebrate nerve tracts and ganglia, the retinal layer and sensitiveness to light, length of the nervous tract, and finally the new doctrine in general with its greater unity of plan.

Die neue Tierpsychologie. Von GEORGES BOHN. Leipzig, Veit & Co., 1912. 183 p.

This essay won a prize of the Paris Academy of Moral and Political Science and is here presented in a German edition. The original bore the title The Origin of the Ability to Think. The author's chief endeavor is always to base psychological upon biological processes and to show the new light in which these latter stand when they are related to psycho-chemical processes. The author assumes that the idea of science is systematic thought and that mechanism is determinism.

Das Inzest-Motiv in Dichtung und Sage. Grundzüge einer Psychologie des dichterischen Schaffens. Von Otto Rank. Leipzig, Franz Deuticke, 1912. 685 p.

This work is very properly dedicated "in gratitude to my highly revered teacher Sigismund Freud." The writer has been working on this topic since 1906 and it is a very comprehensive and thoroughgoing work. In the first section, he discusses the relations between parents and children, the individual roots of the incest phantasy, its type in dramas such as Oedipus, Hamlet and Don Carlos; then in its appearance in Schiller, the step-mother theme, Byron's Parisina, the scheme of the Phaedra, the conflict between father and son, Shakspere's father complex, the Oedipus drama; and in its relations to the literature of the world, its meaning, the incest complex in ancient myth and tradition, Middle Age fables and Christian legends which illustrate it, the relations between father and daughter in myth, saga, Märchen, poetry, life and neuroses, and incest in historical times. The second part treats of the relations between brother and sister and the significance of this complex, how it appears in Grillparzer, the "Ahnfrau" scheme, as seen in Calderon, Voltaire, Goethe's love of brother and sister, its difficulties and stages of development, Byron's relation to this theme, biblical material, how it appears in the literature of Lope, Calderon, Cervantes, Schiller's complex, the brother hate complex as seen in Socrates and Schiller, the tragedies of fate, romanticists like Tieck, von Arnim, Korner, Wagner, the incest motive in modern poetry as seen in Ibsen and contemporary poets.

The mechanistic conception of life. By Jacques Loeb. Chicago, University of Chicago Press, 1912. 232 p.

These essays were written on different occasions, mostly in response to requests for a popular presentation of the results of the author's investigations. The titles characterize their general tendency as an attempt to analyze life from a purely psycho-chemical viewpoint. Repetition is unavoidable to perhaps any view of the technical nature of the subject. This may not be detrimental. The ten chapters are as follows: the mechanistic conception of life; the significance of tropisms for psychology; some fundamental facts and conceptions; concerning the comparative physiology of the central nervous system; pattern adaptation of fishes and the mechanism of vision; on some facts and principles of physiological morphology; on the nature of the process of fertilization; on the nature of formative stimulation (artificial parthenogenesis); the prevention of the death of the egg from the act of fertilization; the rôle of fertilization in the preservation of life; experimental study in the influence of environment on animals.

Grundüge der Psychophysiologie. Von Alfred Lehmann. Leipzig, O. R. Reisland, 1912. 742 p.

All psychologists will welcome this concise text-book by this well known author. We have no space to do justice to the work here. The first book treats of the relations of body and soul, beginning with conscious phenomena, energy and its transformation, life and its operations, the nervous system. The second book is on psychophysics and deals with sensations, visual, auditory, feelings and the rest. The third is devoted to psychodynamics and deals with inhibitions and Bahnung. Then psychic activity, such as attention, discrimination, association, is taken up. Then come psychic complexes like time, space, the ego and Affekte.

Women's position in the laws of the nations. A compilation of the laws of different countries, prepared by the I. C. W. Standing Committee on Laws concerning the Legal Position of Women, with an introduction by Mme. d'Abbadie d'Arrast. Karlsruhe i. B., G. Braun, 1912. 192 p.

This publication grew out of a resolution passed at the Fourth Quinquennial Meeting of the International Council of Women at Toronto in June, 1909, calling for a report of the existing unequal laws in various countries which deal with the relation of women to the home, family, municipality and state. The reports are from a score of countries and each is made by some woman expert in that country. The work concludes with a history of the International Council, a list of its affiliations, committees, etc. The report appears in three languages, English, French and German.

Die Ursachen der jugendlichen Verwahrlosung und Kriminalität. Von HANS W. GRUHLE. Berlin, Julius Springer, 1912. 454 p.

This is a very comprehensive and thorough treatise on its subject, beginning with the fate and personality of the child, relations between ability and environment, and then taking up the different classes of defect. The volume abounds in curves, tables and statistics, and practical suggestions. Its periscope of cases, institutions and literature is wide.

Bau und Leben der Bakterien. Von WILHELM BENECKE. Leipzig, B. G. Teubner, 1912. 650 p.

This comprehensive and thoroughgoing work will perhaps have little interest for most psychologists, although the chapters that deal with the life histories of bacteria, their vitality and conditions of life, etc., will be interesting to all.

Das energetische Imperativ. Von WILHELM OSTWALD. Leipzig, Akademische Verlagsgesellschaft, 1912. 544 p.

We have here an attempt of this well known author to systematize his thought and show its philosophical basis and the kind of social organization that is built upon his thought. He has much to say of relations of organization and internationalism, of educational institutions and theory, and closes with a group of biographies. It is not a systematic work, but cannot fail of course to be stimulating and suggestive.

Zur Psychologie der Aussage. Ein Vortrag. Mit einem Anhang: Ueber die gesetzliche Beseitigung des Zeugeneids. Von JOHANN GEORG GMELIN. Hanover, Helwing, 1909. 98 p. (Zweite Auflage.)

The author first treats the subject in general and then the legal setting aside of the oath of witnesses and concludes with a general summary of opinion concerning the whole subject.

Elemente der Völkerpsychologie. Von WILHELM WUNDT. Leipzig, Alfred Kröner, 1912. 523 p.

This book is not an epitome of the five volumes of Völkerpsychologie, although it covers much the same ground, but it is a new and independent work of a more popular character, which seems to be particularly adapted for a translation into English, which we hope may soon be forthcoming.

Das Gefühl. Von THEOBALD ZIEGLER. Leipzig, G. J. Göschen, 1912. 402 p.

This is a fifth and revised edition of this well known work, the first edition of which appeared in 1893.

The N. E. A. phonetic alphabet with a review of the Whipple experiments. By RAYMOND WEEKS, JAMES W. BRIGHT and CHARLES H. GRANDGENT. Lancaster, Pa., The New Era Printing Co., 1912., 91 p.

This compact little pamphlet is more than a controversial book, although it enters upon a rather sharp polemic against Professor Whipple and seeks "to point out how far from conclusive and in fact misleading at times are the results reached by" him. It is an explanation and discussion of the principles which underly what is known as the scientific key alphabet for use in respelling for pronunciation, dictionaries, encyclopedias, school books, etc.

Backward and feeble minded children: clinical studies in the psychology of defectives with a syllabus for the clinical examination and testing of children. By EDMUND BURKE HUEY. Baltimore, Warwick & York Inc., 1912. 221 p. (Educational Psychology Monographs.)

The author of this work has had an admirable training and this book was well worth writing. The chief topics are classification and terminology, clinical studies of border cases, translation of the data, selected groups, lines of transition from feeble mindedness to non-feeble mindedness, a syllabus for the clinical examination of children, mental functions to be tested and observation, with bibliography, index of cases, subjects and of names.

Denkende Tiere. Von KARL KRALL. Leipzig, Engelmann, 1912. 532 p.

This is a comprehensive account by their master of the famous thinking horse, Hans and his successors, Muhamed and Sariff and bears the subtitle of contribution to knowledge of the animal soul on the basis of original investigations. After treating of the horses in detail, the third part describes how to instruct horses as based upon the experimenter's experience.

Zentralblatt für Psychoanalyse. Herausgeben von Dr. SIGM. FREUD. Schriftleiter Dr. Wilhelm Stekel. I. Jahrgang, Heft 1/12. Wiesbaden, J. F. Bergmann, 1911.

Archives sociologigues. Publieées par Émile Waxweiler. Institut Solvay. Institut de Psychologie. Bulletin 19, 3e Année, 25 Mars 1912. pp. 301-617. (Contributions nouvelles aux Archives Sociologiques.)

A comparison of personal characteristics in dementia praecox and manic-depressive psychosis. By EARL D. BOND, M. D. and E. STANLEY ABBOT, M. D. Reprinted from American Journal of Insanity, vol. 68, January 1912. pp. 359-360.

The relation of practice to individual differences. By FREDERICK LYMAN WELLS. Reprinted from the American Journal of Psychology, January, 1912. Vol. 33, pp. 75-88.

The Hamlet problem and its solution. By EMERSON VENABLE. Cincinnati, Stewart & Kidd Company, 1912. 102 p.

An essay on Hasheesh, including observations and experiments. By VICTOR ROBINSON. New York, Medical Review of Reviews, 1912. 83 p.

La psicologia sociale come contributo alla psicologia individuale. Di GUALTIERO SARFATTI. Estratto dalla Rivista di Psicologia, Anno VIII, N. 4, 1912. 12 p.

The sthenic index in education. By GEORGE V. N. DEARBORN. Reprinted from the Pedagogical Seminary, June, 1912, Vol. XIX, pp. 166-185.

The neurology of apraxia. By GEORGE V. N. DEARBORN, M. D. Reprinted from the Boston Medical and Surgical Journal, Vol. CLXIV, No. 22, pp. 783-786, June 1, 1911.

Notes on the neurology of voluntary movement. By GEORGE VAN NESS DEARBORN, M. D. Reprinted from the Medical Record, May 18, 1912. 48 p.

The nerve-mechanism of voluntary movement. By GEORGE V. N. DEARBORN. Reprinted from the American Physical Education Review, May, 1912. 11 p.

The relation of muscular activity to the mental process. By G. V. N. DEARBORN. Reprinted from the American Physical Education Review, Jan., 1909, Vol. XIV, No. 1. 7 p.

A laboratory-course in physiology based on Daphnia and other animalcules. By GEORGE V. N. DEARBORN, M. D. Sonderabdruck aus dem Biologischen Centralblatt. Bd. XXXII, Nr. 5, ausgegeben am 20. Mai 1912. S. 285-291.

Some factors in the development of voluntary movement in the infant. By GEORGE V. N. DEARBORN. Reprinted from New England Medical Monthly, August, 1911. 11 p.

Abriss der Psychologie. Von HERMANN EBBINGHAUS. 4th ed. Leipzig, Veit & Comp., 1912. 208 p.

Handbuch für Jugendpflege. Hrsg von der Deutschen Zentrale für Jugendfürsorge. Schriftleitung: Fr. Duensing, Berlin. Erste Lieferung. Langensalze, Hermann Beyer & Söhne, 1912. 64 p.

Das Problem der Funktionen des Nervensystems. Von S. BAGLIONI. Jena, Gustav Fischer, 1912. 50 p.

Beiträge zur Universitätsstatistik. Von FRIEDRICH LENZ. Halle a. S., Waisenhaus, 1912. 35 p.

Die Physiologie als Wissenschaft und als Lehre. Von PAUL JENSEN. Jena, Gustav Fischer, 1912. 20 p.

The founders of modern psychology. By G. STANLEY HALL. New York, D. Appleton & Co., 1912. 471 p.

The Indian or mound builder. By THOMAS BECKWITH. Cape Girardeau, Mo., Naetor Brothers, 1911. 135 p.

Philosophische Betrachtungen: Fragmente aus dem literarischen Nachlass. Von GUSTAV LEVINSTEIN. Berlin, Leonhard Simion Nf., 1912. 99 p.

Psychologische Untersuchungen, hrsg von THEODOR LIPPS. II. Band, 1. Heft. Leipzig, Wilhelm Engelmann, 1912. 110 p.

Die Instinktbedingtheit der Wahrheit und Erfahrung. Von FRIEDRICH BODEN. Berlin, Leonhard Simion Nf., 1911. (Bibliothek der Philosophie, hrsg. von Ludwig Stein. 1. Band. Beilage zu Heft 4 des Archivs für systematische Philosophie, Band 17,) 80 S.

Psychologie und Medizin. Von O. KÜLPE. Leipzig, Wilhelm Engelmann, 1912. 81 S. (Sonderdruck aus der Zeitschrift für Pathopsychologie. 1. Band.)

NOTE

On the occasion of his eightieth birthday, August 16, 1912, Professor Wundt was presented by some sixty of his former students and other friends with the sum of Mk. 7000, to constitute a *Wilhelm Wundt Stiftung* of which he should dispose at his discretion. After expressing his thanks for the gift, Professor Wundt declared his intention of employing the sum for the purchase of instruments in the domain of psychological acoustics and phonetics, and of depositing the instruments in the Leipzig Laboratory. Experimental psychology, he remarks, may render service in this field to such related disciplines as linguistics, social psychology, and the science of music. The apparatus will bear the mark of the *Stiftung,* and the names of contributors will be preserved in the archives of the Laboratory.

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TABLE I. UPPER CASE. I

SHOWING THE AVERAGE DISTANCE, EXPRESSED IN CM., AT WHICH EACH LETTER OF EACH FACE WAS READ (TWELVE READINGS, LETTER WHICH WAS PRESENTED FOR IDENTIFICATION; AND THE NUMBER INDICATES THE AV

American Typewriter		Bulfinch		Caslon O. S.		Century O. S.		Century Expanded		Cheltenham O. S.		Cheltenham Wide	Clearface		Cushing	
A	221.7	A	280	A	270	A	300	A	300	A	291.7		A	281.9	A	2
B	176.7	B	231.7	B	206.7	B	221.7	B	213.3	B	210		B	221.7	B	2
C	195	C	293.3	C	278.3	C	285	C	271.2	C	290		C	288.8	C	2
D	183.3	D	275	D	265	D	281.7	D	273.3	D	270		D	251.7	D	2
E	193.3	E	230.8	E	213.3	E	241.7	E	240.8	E	259.2		E	229.6	E	1
F	191.7	F	254.2	F	210.8	F	265	F	265.8	F	241.7		F	270.7	F	2
G	169.2	G	276.7	G	256.7	G	265	G	255	G	275		G	258.6	G	2
H	190	H	266.7	H	230	H	250	H	239.2	H	256.7		H	261.2	H	2
I	230	I	300	I	285	I	295	I	275	I	268.3		I	327.2	I	2
J	226.7	J	290	J	285	J	300	J	301.7	J	281.7		J	323	J	2
K	177.5	K	262.5	K	220.8	K	256.7	K	241.7	K	254.2		K	236	K	2
L	248.3	L	305	L	281.7	L	308.3	L	301.7	L	300		L	315.1	L	2
M	189.2	M	316.7	M	290	M	313.3	M	298.3	M	303.3		M	323	M	3
N	184.2	N	246.7	N	244.2	N	258.3	N	241.7	N	261.7		N	247	N	2
O	186.7	O	293.3	O	267.5	O	293.3	O	265	O	278.3		O	274.5	O	2
P	190	P	301.7	P	245	P	263.3	P	281.7	P	270.8		P	286	P	2
Q	214.2	Q	308.3	Q	270	Q	268.3	Q	275	Q	291.7		Q	285	Q	2
R	186.7	R	227.5	R	200.8	R	210.7	R	235	R	255		R	216.9	R	1
S	168.3	S	236.7	S	197.5	S	225	S	209.2	S	215		S	211.2	S	2
T	220.8	T	276.7	T	280	T	305	T	280	T	271.2		T	273.9	T	2
U	200.8	U	268.3	U	247.5	U	256 7	U	276.7	U	266.7		U	269.1	U	2
V	205	V	275	V	255.8	V	281.7	V	278.3	V	288.3		V	277.6	V	2
W	165	W	310.7	W	291.7	W	306.7	W	316.7	W	306.7		W	318.2	W	3
X	192.5	X	260.8	X	237.5	X	257.5	X	250	X	263.3		X	247	X	2
Y	221.7	Y	268.3	Y	260	Y	271.7	Y	261.7	Y	249.2		Y	266	Y	2
Z	187.5	Z	261.7	Z	228.3	Z	250	Z	237.5	Z	261.7		Z	240.7	Z	2
verage	196.8		273.8		250.7		270.4		264.8		268.5			269.3		2

The Upper Case letters of Cheltenham Wide are identical with those of Cheltenham Old Style.

E. ISOLATED LETTERS

GS, SIX OBSERVERS). THE FIRST COLUMN IN EACH DIVISION OF THE TABLE SHOWS THE ACTUAL SIZE AND FORM OF THE E AVERAGE DISTANCE, FROM THE EYE, AT WHICH THE LETTER WAS CORRECTLY IDENTIFIED

shing O. S.		Cushing No. 2		Cushing Monotone		Della Robbia		De Vinne No. 2		Jenson O. S.		News Gothic		Ronaldson O. S.		*Average*
257.5	A	241.7	A	234.2	A	293.3	A	265	A	300	A	286.7	A	263.3		272.4
204.2	B	190.8	B	179.2	B	211.7	B	211.7	B	229.2	B	230.8	B	195		208.9
259.1	C	243.3	C	251.7	C	282.5	C	252.5	C	310	C	276.7	C	259.2		265.1
255.8	D	218.3	D	236.7	D	243.3	D	249.2	D	300	D	265	D	246.7		254.3
198.3	E	209.2	E	192.5	E	228.3	E	226.7	E	245.8	E	240	E	208.3		223.9
234.2	F	208.3	F	217.5	F	244.2	F	243.3	F	276.7	F	253.3	F	241.7		241.6
220	G	197.5	G	214.2	G	256.7	G	184.2	G	273.3	G	247.5	G	213.3		237.6
213.3	H	202.5	H	214.2	H	283.3	H	233.3	H	273.3	H	253.3	H	240		240.5
290	I	244.2	I	251.7	I	301.7	I	273.3	I	296.7	I	296.7	I	270		280.4
295	J	271.7	J	260	J	315	J	275.0	J	320	J	295	J	281.7		287.5
228.3	K	205.8	K	200	K	217.5	K	243.3	K	270	K	231.7	K	229.2		231.7
296.7	L	261.7	L	266.7	L	296.7	L	290	L	311.7	L	300	L	283.3		291.1
315	M	273.3	M	275	M	321.8	M	293.3	M	318.3	M	308.3	M	268.3		293.8
221.7	N	201.7	N	215	N	258.3	N	225	N	270	N	243.3	N	225		235.5
230.8	O	215.8	O	219.2	O	275	O	226.7	O	296.7	O	250	O	253.3		254.0
255	P	238.3	P	229.2	P	252.5	P	263.3	P	296.7	P	278.3	P	229.2		257.9
255.8	Q	220	Q	245	Q	246.7	Q	240.9	Q	295	Q	278.3	Q	231.7		261.7
198.3	R	196.7	R	180	R	228.3	R	193.3	R	234.2	R	240	R	205.8		214.0
210	S	182.5	S	183.3	S	203.3	S	200	S	223.3	S	216.7	S	203.3		205.7
280	T	219.2	T	237.5	T	295	T	251.7	T	308.3	T	280.8	T	251.7		268.9
233.3	U	220	U	232.5	U	275	U	240.9	U	270.8	U	273.3	U	237.5		251.3
246.7	V	237.5	V	236.7	V	291.7	V	248.3	V	310	V	264.2	V	256.7		263.5
331.7	W	288.3	W	285	W	343.3	W	315	W	306.7	W	316.7	W	301.7		300.2
240	X	212.5	X	222.5	X	252.5	X	236.7	X	256.7	X	240	X	228.3		239.8
250	Y	241.7	Y	233.3	Y	263.3	Y	225	Y	261.7	Y	258.3	Y	250.8		252.1
218.3	Z	204.2	Z	207.5	Z	256.7	Z	216.7	Z	270	Z	255.8	Z	210.7		233.8
247.6		224.8		228.4		266.8		243.2		281.7		264.6		241.7		252.8

TABLE II. LO

HOWING THE AVERAGE DISTANCE, EXPRESSED IN CM., AT WHICH EACH LETTER OF EACH FACE WAS READ (TWELVE READI
LETTER WHICH WAS PRESENTED FOR IDENTIFICATION; AND THE NUMBER INDICATES THE A

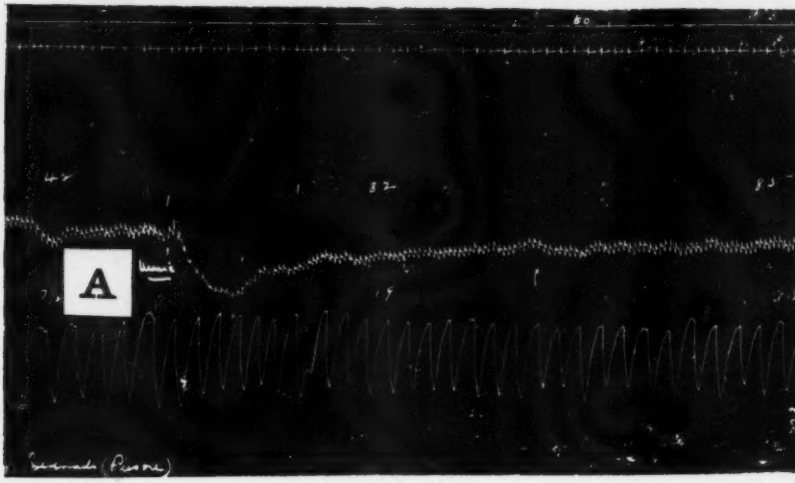
American Typewriter		Bulfinch		Caslon O. S.		Century O. S.		Century Expanded		Cheltenham O. S.		Cheltenham Wide		Clearface		Cushi	
a	184.2	a	185	a	170.8	a	197.5	a	196.7	a	155	a	190.8	a	182.1	a	
b	208.3	b	233.3	b	190	b	245	b	233.3	b	221.7	b	245	b	223	b	
c	168.3	c	207.5	c	185	c	230	c		c	180.8	c	200.8	c	235.9	c	
d	230	d	258.3	d	253.3	d		d	273.3	d	261.7	d	276.7	d	283.4	d	
e	162.5	e	181.7	e	165.8	e	199.1	e	187.5	e	169.2	e	185.8	e	179.8	e	
f	241.7	f	261.7	f	225	f	256.7	f	256.7	f	235	f	241.7	f	241.7	f	
g	203.3	g	251.7	g	182.5	g	245	g	241.7	g	195.8	g	216.7	g	250	g	
h	207.5	h	241.7	h	210.8	h	235	h	238.3	h	211.7	h	238.3	h	247	h	
i	206.7	i	243.3	i	209.2	i	245	i	215.8	i	235	i	251.7	i	213	i	
j	256.7	j	228.3	j	235	j	240	j	283.3	j	234.2	j	248.3	j	264.4	j	
k	188.3	k	236.7	k	197.5	k	240	k	235	k	211.7	k	224.2	k	223.2	k	
l	230	l	256.7	l	219.2	l	245	l	252.5	l	240	l	254.2	l	280.2	l	
m	195	m	336.7	m	291.7	m	310	m	286.7	m	295	m	315	m	325.1	m	
n	195.8	n	213.3	n	190	n	213.3	n	199.2	n	181.7	n	208.3	n	213.7	n	
o	188.3	o	220	o	180.8	o	211.7	o	213.3	o	181.7	o	189.2	o	199.5	o	
p	238.3	p	271.7	p	220.8	p	240	p	240	p	223.3	p	247.5	p	259.7	p	
q	233.3	q	240	q	221.7	q	233.3	q	233.3	q	221.7	q	219.2	q	234.4	q	
r	210.8	r	216.7	r	203.3	r	216.7	r	225	r	187.5	r	214.2	r	215.4	r	
s	149.2	s	167.5	s	145	s	167.5	s	165	s	138.3	s	160	s	150.4	s	
t	198.3	t	230.8	t	180.8	t	206.7	t	221.7	t	183.3	t	190	t	228	t	
u	198.3	u	225	u	185	u	212.5	u	198.3	u	177.5	u	197.5	u	207.4	u	
v	195	v	240	v	180.8	v	230	v	217.5	v	205	v	223.3	v	225.4	v	
w	183.3	w	271.7	w	243.3	w	266.7	w	268.3	w	263.3	w	293.3	w	296	w	
x	180.8	x	211.7	x	171.7	x	200	x	195	x	169.2	x	184.2	x	178.1	x	
y	230	y	245	y	221.7	y	230.8	y	218.3	y	222.5	y	236.7	y	237.5	y	
z	159	z	196.7	z	162.5	z	182.5	z	171.7	z	164.2	z	179.2	z	171.4	z	
verage	201.7		233.6		201.7		228.0		226.7		206.4		224.3		229.5		

LOWER CASE

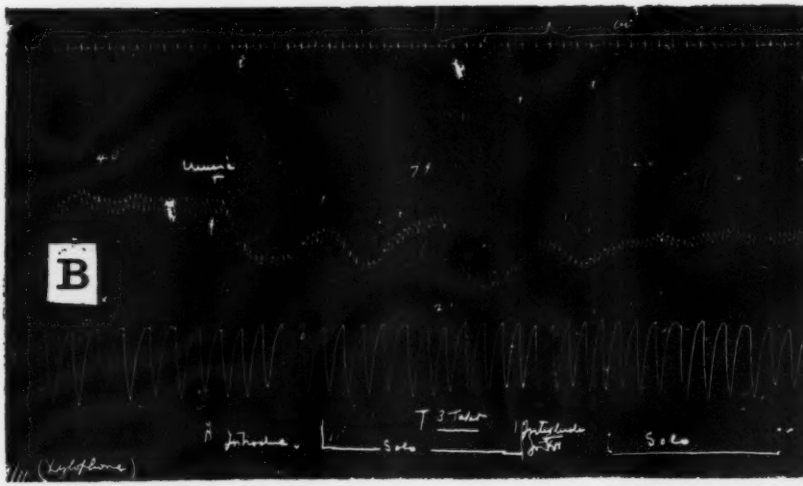
EADINGS, SIX OBSERVERS). THE FIRST COLUMN IN EACH DIVISION OF THE TABLE SHOWS THE ACTUAL SIZE AND FORM OF THE HE AVERAGE DISTANCE, FROM THE EYE, AT WHICH THE LETTER WAS CORRECTLY IDENTIFIED

Cushing O. S.		Cushing No. 2		Cushing Monotone		Della Robbia		De Vinne No. 2		Jenson O. S.		News Gothic		Ronaldson O. S.		*Average*
a	173.3	a	155.8	a	155.8	a	167.5	a	174.2	a	183.3	a	190	a	169.2	177.0
b	206.7	b	171.7	b	203.3	b	223.3	b	195.8	b	220	b	245	b	219.2	217.8
c	179.2	c	174.2	c	171.7	c	181.7	c	182.5	c	197.5	c	221.7	c	190.8	193.8
d	260	d	205.8	d	233.3	d	276.7	d	253.3	d	246.7	d	256.7	d	245	254.3
e	164.2	e	140	e	146.7	e	175	e	170	e	191.7	e	191.7	e	165	173.5
f	232.5	f	184.2	f	178.3	f	260	f	205	f	225	f	263.3	f	235	233.0
g	231.7	g	225.8	g	215	g	218.3	g	196.7	g	202.5	g	258.3	g	198.3	220.8
h	211.7	h	190.8	h	200	h	236.7	h	205	h	220	h	235.8	h	232.5	222.7
i	231.7	i	200	i	215	i	219.2	i	214.2	i	231.7	i	249.2	i	204.2	224.1
j	227.5	j	218.3	j	208.3	j	210.8	j	236.7	j	210	j	280.8	j	247.5	239.4
k	221.7	k	183.3	k	200	k	206.7	k	215	k	230	k	233.3	k	224.2	216.9
l	232.5	l	208.3	l	199.2	l	250	l	190.8	l	251.7	l	226.7	l	243.3	236.3
m	315	m	273.3	m	276.7	m	295	m	315	m	291.7	m	326.7	m	300	296.8
n	172.5	n	162.5	n	163.3	n	203.3	n	197.5	n	206.7	n	220	n	190	195.7
o	172.5	o	170	o	175	o	193.3	o	170.8	o	188.3	o	207.5	o	180	190.1
p	245	p	205	p	201.7	p	239.3	p	225	p	255	p	248.3	p	217.5	236.1
q	235	q	196.7	q	206.7	q	238.3	q	212.5	q	220.8	q	257.5	q	217.5	226.4
r	205	r	175.8	r	183.3	r	190	r	198.3	r	196.7	r	237.5	r	181.7	203.6
s	145.8	s	145.8	s	145.5	s	138.3	s	154.2	s	150	s	177.5	s	141.8	152.6
t	208.3	t	169.2	t	179.2	t	191.7	t	191.7	t	188.3	t	223.3	t	202.5	199.6
u	175.8	u	176.7	u	165	u	195	u	194.2	u	180	u	215	u	185.8	193.1
v	225.8	v	183.3	v	205	v	205.8	v	199.2	v	219.2	v	235.8	v	219.2	213.1
w	281.7	w	201	w	233.3	w	280	w	265	w	270	w	305	w	263.3	261.6
x	187.5	x	157.5	x	155	x	171.7	x	185	x	192.5	x	196.7	x	170	181.7
y	227.5	y	194.2	y	195.8	y	226.7	y	208.3	y	241.7	y	246.7	y	210	224.6
z	157.5	z	156.7	z	143.3	z	175	z	170	z	171.7	z	199.2	z	185	171.6
	212.6		185.6		190.6		214.2		204.8		214.7		236.4		209.2	213.7

Eight typical records are reproduced in order to illustrate certain
been described in the text. These records read from left to right;
downward direction indicates inspiration; upward direction, expiratio

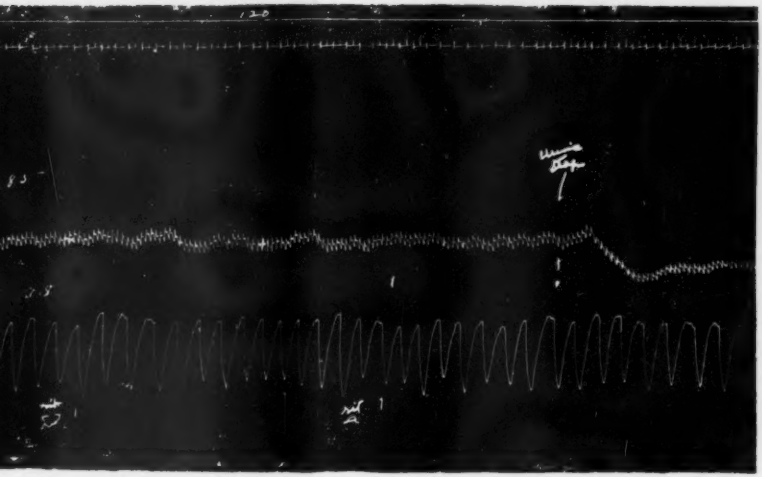


Observer R. *Pierne,* Serenade; String Quartette. Characteristic initial
uniform course until after the cessation of the music; then a second abr
music-period.

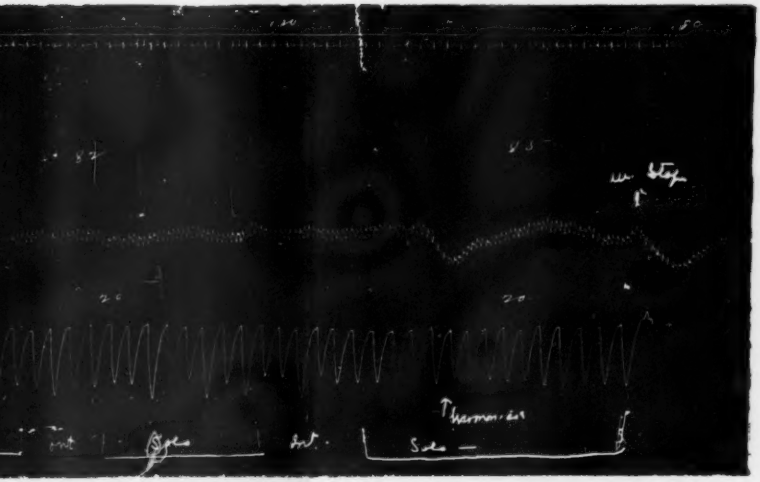


Observer R. *Benedict,* Carnival of Venice; Xylophone. The undulating
shiftings in the observer's attention; a state of undistracted attention was
interest in the harmonics coincided with the subsequent rise and fall near

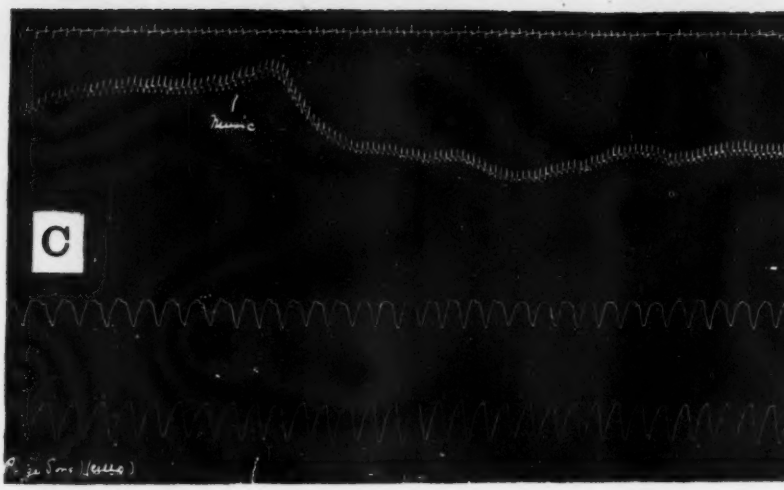
ertain of the more significant physiological phenomena which have
ht; the time-line marks seconds. In the respiration tracings,
iration.



initial fall in volumetric curve; thereafter the volume maintains a fairly
abrupt fall. Introspection showed undistracted attention throughout the

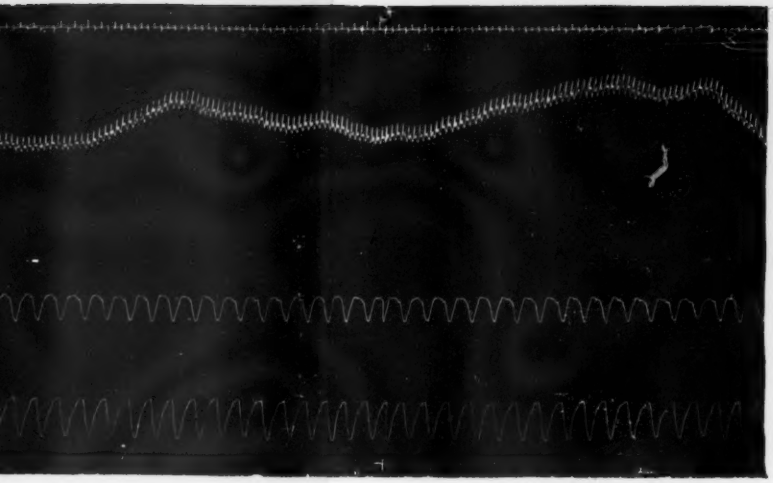


lating waves at the beginning of the music-period coincide with rapid
was reported in the middle region of the music-period, and an especial
near the end of the music-period.

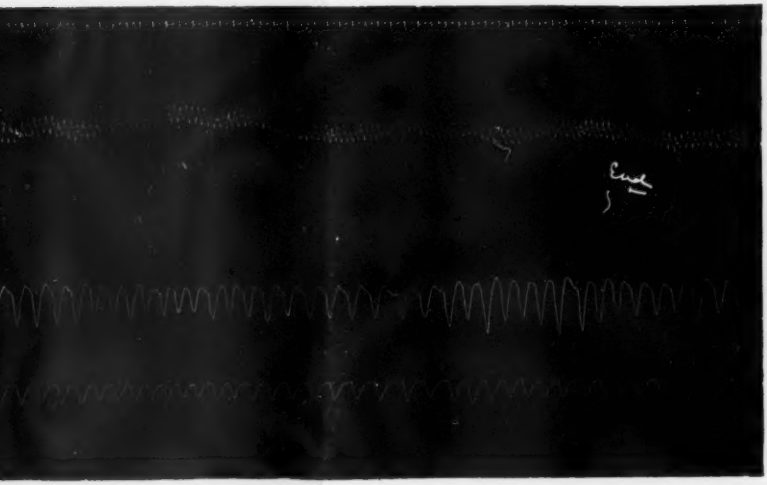


Observer H. *Wagner,* Prize Song; Cello. The introspection revealed music, slight attempts to analyse during the remainder of the first m before the end. No emotion was reported. (The close of the music-per

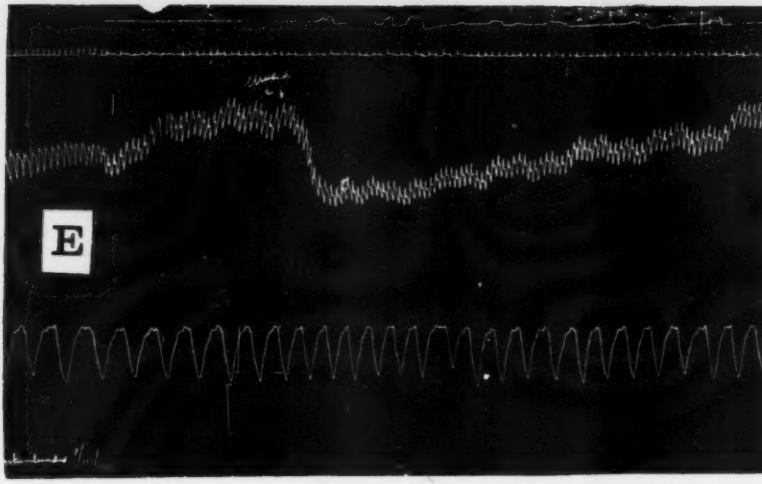
Observer S. *Braga,* Angel's Serenade; Violin and Cello. Introspec ion present, especially near the end.



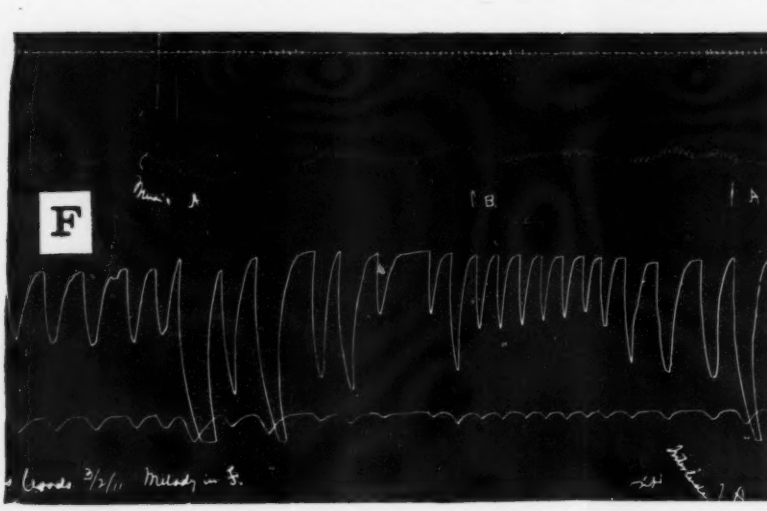
ealed a dreamy state during the fore-period, a slow mental reaction to the
st minute, little interest in the music, and a brief lapse of attention just
ic-period does not appear upon this record.)



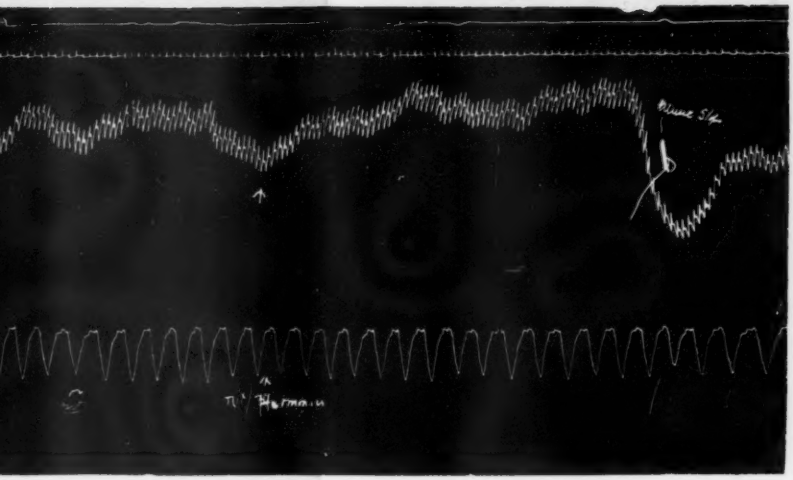
ec ion showed a passive attention throughout. Excitement and mood were



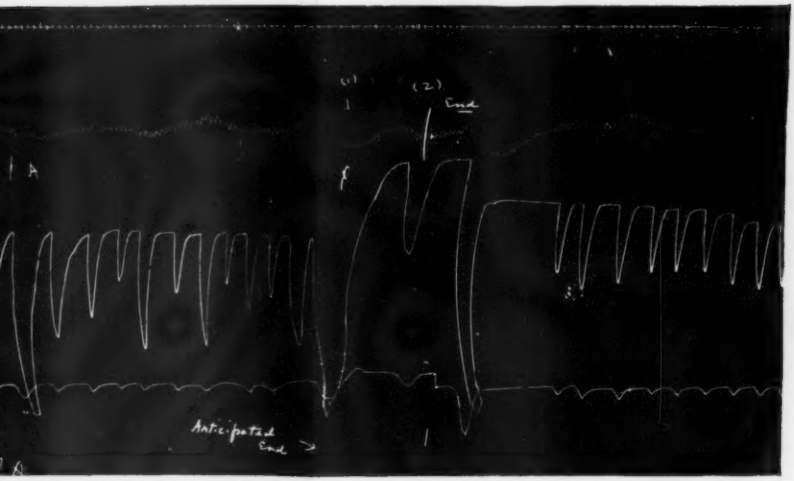
Observer Fn. *Thomas.* Mignon Gavotte: String Quartette. Passiv
sudden advent of the music; little analytic interest; and a gradual drifti
curve, indicated by the arrow, the auditor was keenly interested in the



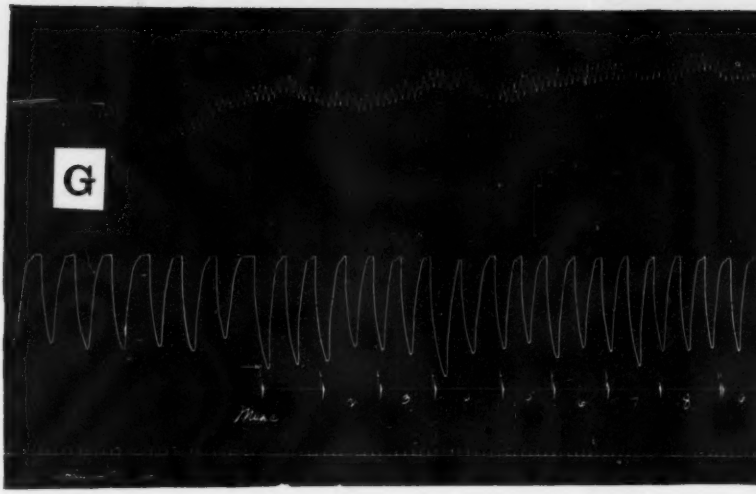
Observer W. *Rubenstein.* Melody in F; Violin. This plate shows a
observer. A, B, A refer to the outline of the music: the respiration du ri
tarded and deeper respiration during the interlude which reintroduces
anticipated. Introspection showed much emotion, including excitement a



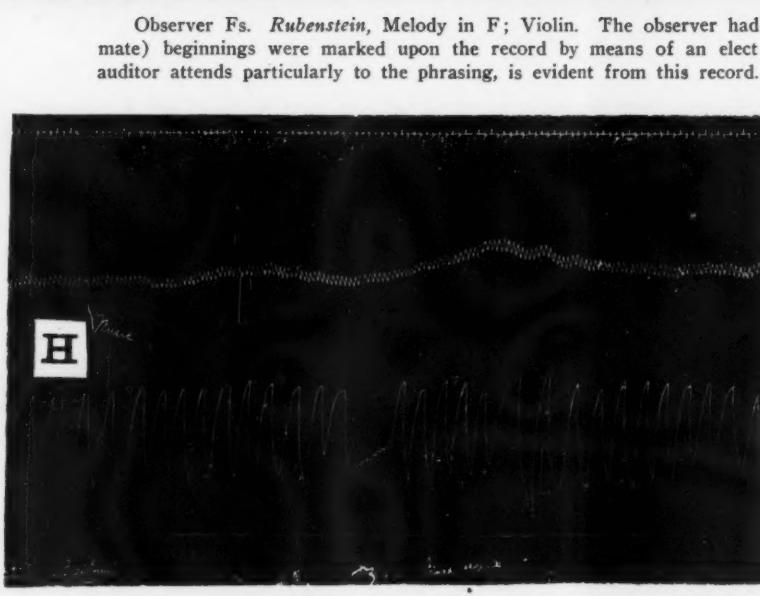
Passive attention during the latter part of the fore-period; surprise at the drifting into a dreamy state. The *finale* was anticipated. At the drop in the the retard and the harmonics.



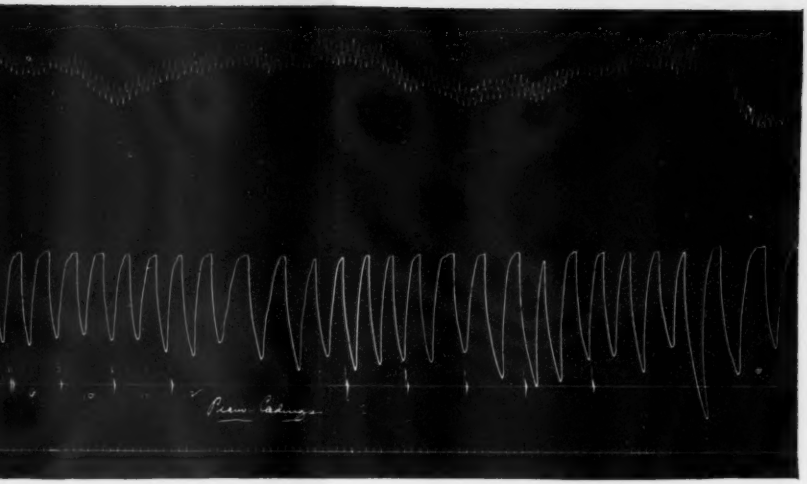
ws a marked disturbance of respiration, which was characteristic of this du ring B is characteristically different from that during A. Note the re- uces A, and the long expiration,—twelve seconds,—while the *finale* was being ent and mood.



Observer Fs. *Rubenstein,* Melody in F; Violin. The observer had
mate) beginnings were marked upon the record by means of an elect
auditor attends particularly to the phrasing, is evident from this record.



Observer Fs. *Beethoven,* Leonore Overture; Orchestra. This plate
in volumetric curve did not occur Introspection showed that here the au
mood began at the point B.



r had been instructed to attend to the phrases (see p. 252),—whose (approxi-
electro-magnetic recorder. That respiration coincides with phrase, when the
ecord.

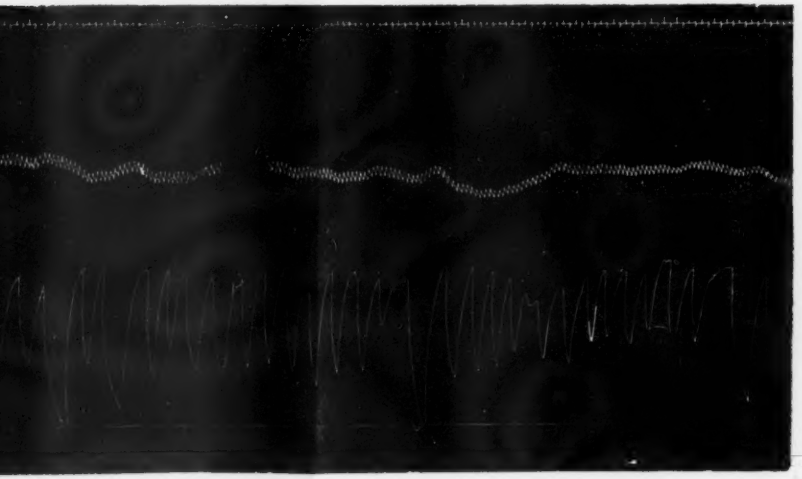


plate shows one of the fourteen cases where the characteristic initial drop
e auditor was scarcely aware of the music and that attention was passive; a